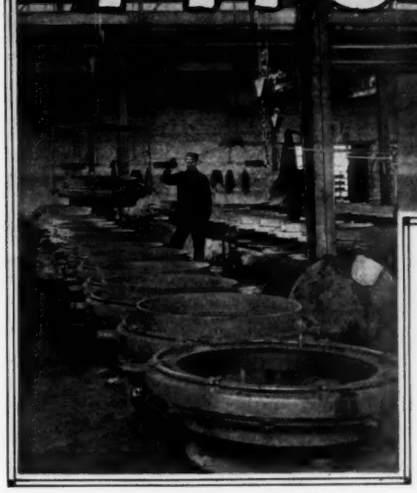
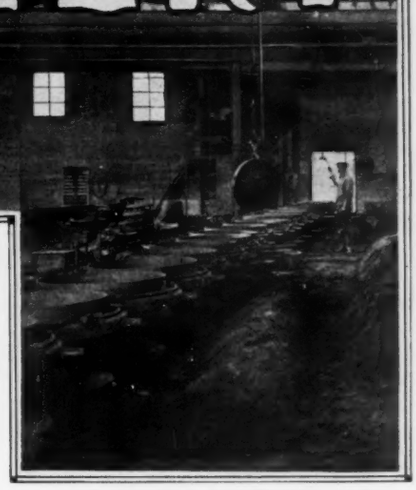
THE FOUNDRY

A Monthly Journal for all Departments of the Foundry Business

Cleveland, Ohio, December, 1916





Air Furnace Iron for Cast Car Wheels

Vol. 44, No. 12 Whole No. 292

By Eliminating Objectionable Impurities From Car Wheel Metal While it is in the Molten State Subsequent Failure in Service Can Be Prevented

By Charles V Slocum

A STRONG argument in favor of the chilled car wheel is the comparatively low price at which the new product is sold. Also, it has the advantage of making an excellent grade of scrap sought after by steel mills as well as by the wheel makers. The statement frequently is made that since steel has largely supplanted cast iron for many purposes, it eventually must supplant the iron wheel. Although the steel wheel has been on the market for many years, by no means a large percentage of the total number of wheels in use are made of steel. Nevertheless it would seem that the day of the chilled wheel must wane eventually unless changes and improvements are given attention with a view to meeting the prevailing tendency to greater loads and heavier trains.

To avail ourselves of the best interpretation of values relating to such questions it becomes desirable to investigate, from time to time, details which have made it possible for a product like the chilled wheel to achieve popularity and a large demand.

Failure of the Car Wheel

It is not the whole truth to assert that men's lives often depend entirely upon the *safety first* efforts and regulations in connection therewith among the railways. It not infrequently happens that aparently every precaution is taken to prevent an accident by examination and even by testing every bolt, joint and connection only to receive in return an exasperating experience through the breakage of some trusted implement or overstrained portion of the equipment. Candor compels us to admit that among the latter is often found a car wheel.

Accurate Manufacturing Processes

The more deeply we look into the subject the more firmly we become convinced that our lives are saved sometimes not so much by the care taken in preventive measures to avoid accident as by the reliability and definite accuracy of the manufacturing process upon which, in reality, after all other preventive measures have been taken, depends the possibility of sustaining the sudden strains and the often prolonged stresses of freight or passenger service. Sometimes, even in the best regulated foundries, abnormalities have occurred so obscurely located that every man whose duty it was to prevent shipment of anything but perfect equipment has overlooked the hidden defect. Human ingenuity prepares tests of various kinds, but in the particular direction of accidents we have only to refer to the records to find that no such thing as absolute perfection has yet been reached in the foundry business, in this problem of eliminating internal defects or abnormal weaknesses.

In several lines of railway equipment, among which car wheels are classed, the obsolete present-day practice prevails of testing a limited number of specimens from a day's work or from a heat of metal and trusting in Providence that all the other portions of that day's output or heat are as good as the samples, for beyond surface examinations the others in reality remain untested. The difficulty seems to be that the tremendous demand throughout the country involves the shipment of so much material every day that a close inspection has become impracticable.

In order to reconcile these conditions it appears that many railway lines have adopted the plan of arranging for as much auxiliary selection and inspection as possible. In the case of steel rails for instance, the finished product is not only inspected, but every heat of steel must be regarded as carrying practically a self-evident demonstration of careful preparation by means of reports giving analysis, physical and chemical tests, etc., all subject to verification by the purchaser.

Safe Rails and Wheels

Probably no other metal used in railroad service should so clearly show, beyond all possible doubt, the absolutely undeniable strength and reliability of the material in the finished product and the positive absence of abnormalities as should be demonstrated in both rails and car wheels.

A powerful factor in the solution of

the question of dependability in such heavy material is the presence or absence of impurities. When we compare the different tests to which rail steel and car wheel iron are subjected in manufacture before the product is ready for pouring, we find in the making of rails the unmistakable care exercised in the preparation of metal.

In the opinion of the writer the very first requirement in standardizing any particular metal product is the thorough elimination of objectionable impurities from the metal while the latter is in a molten state or, in other words, to pursue the causes of defects, of breakage and of disaster until having prepared the metal for *safety first* it will not fail in performance afterward.

Taping the Wheels

An important feature of the present system of inspecting chilled wheels is called taping. This is done for the double purpose of distinguishing between wheels of high and low shrinkage as means of preventing wheels of high shrinkage and high chill and wheels of low shrinkage and low chill from going into service. Taping also involves stencilling a number on the wheel, which corresponds with the circumference measurement and enables the car shop or repair shop men to select *mates* or wheels of like diameters for each axle.

The inspector is authorized to select his test wheels at random, preferably choosing a wheel or two with the smallest circumference measurement or tape number. He invariably is compelled to seek such wheels as in his judgment are the least likely to meet the requirements required by his company, on the theory presumably that if the least eligible or poorest wheel passes the test the others are probably safe for service. It is customary to accept the wheels, thus tested by proxy, although the interests of his company have only been partially safeguarded.

In a lot of wheels for one day's heat the variations in metals charged into the cupola are often productive of still other variations, sometimes causing difficulties at the ladle, sometimes sufficiently distributed beyond this point so that no discovery is made in the ordinary practice until at length the inspector performs his customary feat of passing judgment upon uniformity of 100 or more interiors by an examination of an equal number of exteriors.

It is true that the cupola practice in regard to car wheels is by no means below the average of other iron foundries, but it is impossible to change a number of metals lacking uniformity (especially old wheels) into a new and thoroughly standardized, life-saving product by the variable system now in vogue.

The purification of metal and making it uniform as relating to car wheels manifestly only can be acomplished when the iron is in a fluid state and under conditions which permit holding the fluid metal without danger of cooling or dulling while tests and analyses are being made by means of which to inform the melter of the exact ingredients of his iron at that stage of the process and precisely what changes, if any, must be made to bring the mixture into conformity with the standard required.

A manufacturer in any line, by accident sometimes may produce a wonderful product, but in order to maintain that product at the same high standard, it is a self-evident fact that he must know exactly not only what steps to take at every stage of the process, but how to duplicate the performance every day.

It is well-known that in acid open-hearth steel its quality is largely determined by the very careful selection of the stock to be used while the basic open-hearth method is designed to utilize all material, good, bad and indifferent.

To bring about good results under the latter combination we are able to assume that no practicable dissemination or combination of efforts could bring about a desirable result after the metal was poured into the molds. We can compare this method by which the metal for rails is carefully deoxidized in the furnace and the impurities removed, with the one for wheels which depends upon the constant forcing of air through the molten fluid up to the moment of tapping as a means of reduction, but which introduction of oxygen can by no possibility be considered as a factor in purification.

Oxides in Car Wheel Metal

The modern car wheel, however, may be said to belong to the purely speculative class, at least up to the present time, for the following reasons: Oxides are in all iror and none-the-less in car wheels composed in most cases, as required, of 60 per cent of old wheels removed from service. These scrap wheels have usually been subjected to remelting, again and again and every trip through the cupola adds its quota of oxides to the metal.

It has been claimed that ferro-manganese used in considerable quantities, will purify a chilling iron without other attempts at deoxidation, but there also are certain other impurities that must be removed which are injurious, and while these objectionable influences are reduced to some extent by the use of manganese the latter cannot do it all. In operating a cupola, adding manganese with the charges induces a decided stench as a result of the quantity of sulphur released through the slag. A neutral observer comes to the inevitable conclusion that something favorable to the metal has been accomplished by this release although he may not know that unscrupulous manufacturers sometimes prefer a liberal sulphur content as a means of increasing the depth of chill in the finished wheel.

Manganese Chill

In order to secure a specified depth of chill the average manufacturer of chilled iron using the cupola method often finds himself between the celebrated fireman and the deep sea, not only because he must have a liberal depth of combined carbon in the tread of his wheel and because his own interests demand a hard chill for purposes of competitive mileage, but the improvement which he induces by the use of manganese and the consequent reduction in percentage of sulphur is offset by the fact that in removing, at least partially, this brittle and hardening impurity, the metal is necessarily softened to a noticeable extent and a less durable or softer chill is the result, sometimes known as a manganese chill.

Whenever it may be said that manganese itself brings about an occasional defect in chilled iron quite another phase of the problem and a serious one is introduced. It seems essential that all wheels should be free from all injurious elements and it certainly cannot be considered worth while to endeavor to escape from one difficulty by inducing another.

It is not the common practice to add manganese in the cupola, although chemists and metallurgists maintain that it is best to make all modifications of the metal during the melt or, in other words, before the fluid iron or steel reaches the ladle. The usual method is to add manganese in the pouring ladle and it frequently happens, that in order to provide against short-pouring a greater quantity of iron is sent to the molder than he can use in the casting and wheel head. This excess of metal remains in the ladle and becomes a part of the next ladle of iron as the wheels are poured in rotation. This excess metal is duller than the fresh material poured in on top of it, resulting in a combination of evils. Sometimes *streaky* wheels are one of the products of the combination mentioned; a surplus of manganese is sometimes found in the hub; a more or less dangerous wheel is produced and it becomes necessary to observe whether the wheel has been thoroughly relieved of all shrinkage strains, if in fact the order of procedure ever discovers the malpractice.

It usually is the theory of the foundryman that the molder and helper who make the wheel are responsible as to whether the casting turns out good or bad and on this basis the office, with

few exceptions, charges back to these men all defective castings not available for shipment. At this point it becomes necessary to prove conditions. The molder is taken to task and is positive, in a case of dull iron indications, that the wheel in question was all right when it left his floor and must have been delayed on the way to the pits, or some other excuse is offered. We are inclined to doubt that faulty work on the part of the molder is the cause of even occasional wrecks due to wheel failures. It is obviously a fact that good wheels necessarily are made of good metal and the latter cannot and does not deteriorate.

The usual objection offered against changing the established practice is that no way exists of improving the present method by means of which several hundred wheels per day may continue to be turned out in same plant. Such a statement naturally intends as the basis of the objection the regular specifications as outlined and in use by the leading railroads. They require a certain depth of chill, certain thickness of plates, contour of tread, flange, etc. A well-known engineer of tests informed the writer some time ago that his road contemplated building its own car wheel foundry because the wheel makers did not favor changing their practice.

Chilled Roll Makers Lead

In methods and in facilities the chilled roll makers are far in the lead in the manufacture of so-called hard or chilling irons. The conditions which they have to meet are more severe than in car wheel making. The roll maker must produce a heavy, durable chill; the rolls must have the same mottle between the white and gray iron; the latter must be soft back of the chilled section; the ends must be turned down in the lathe and the whole casting, when finished, in most instances must be guaranteed for a term of years in the severest service to which chilled iron is subjected, namely, rolling steel ingots, billets and bars down to specified size and shape.

The chilled roll maker is able to meet the severest possible specifications with comparative ease because his ultimate results are brought about not only by chemical analyses of materials used and of specimens of the partially made and of the finished product, but tests are made at all stages of the process until the product corresponds with the specifications in every detail. The metal is not allowed to be teemed into the reservoir ladle until the right proportions of each element have been secured.

A peculiar feature of chilled roll making is that the manufacturers not only turn out castings as light as 200 pounds, but they sometimes weigh a couple of tons each so that the conditions are far more trying than in the car wheel foundry making castings that vary (from the lightest to the heaviest) usually not more than 200 or 300 pounds, the lightest wheels being seldom under 500 pounds and the heaviest usually not over 850 pounds per casting.

Melting Metal for Rolls and Car Wheels

That a proper understanding may be had of the comparison between car wheel practice and that of chilled roll making it should be said that the wheels are made exclusively by the cupola method with its necessity for a large number of charges per heat and the unavoidable variations induced by the separate melting of each charge as it passes through the melting zone. Chilled rolls are made in large quantities from a single batch of iron which is teemed into a bottom-pour ladle carrying the entire heat of an air furnace with a capacity of 25 to 50 tons. A blanket of slag covers the top of the ladle as soon as the metal is teemed and the iron remains hot until every casting is poured, each casting being identical with the others as to analysis.

The greatest economies are possible in the manufacture of wheels by this same system used for rolls because of the larger units and the practicability of using a number of labor-saving devices. It would be possible to make, pour and pit 300 wheels in eight hours or any multiple of this number of wheels in exactly the same length of time, through the arrangement of floors and pits, the use of overhead traveling cranes, reduced time by using two ladles of iron only instead of 300, one handling of each hot wheel, etc. In an output of 900 wheels per day six test wheels or one per 50-ton ladle are all that should be necessary as only the six possible variations in the metal from six different heats could ordinarily occur, as compared to a number in the cupola method running from 100 variations or so up to 200 or thereabouts, according to the size of the charges.

Purification of Car Wheel Iron

Mention should be made of the fact that by the air furnace method properly looked after, anything more than a very moderate amount of sulphur, say 0.03 per cent, is entirely unnecessary in the finished wheel, due not only to the use of manganese in the bath where it practically eliminates sulphur and also acts as one of the deoxidizers, but it should be remembered as a comparison that cupola iron invariably takes up sulphur from the coke so that the finished, cupola-made, iron wheel frequently contains more sulphur than the original metal from which it was made.

Theoretically, car wheel iron requires as much or more cleansing or purification than any other iron because the service in which it is used is peculiarly dangerous to human life. Such purification, it would seem therefore, should be made obligatory especially in view of modern conditions of speed and load. It may be true that car wheels in general are more or less perfectly adapted to the requirements, but unless the method of manufacture insures greater uniformity than is practicable with almost numberless charges and other variable factors, it cannot be said that modern ideas in foundry practice have been absorbed and used.

In my paper on the modern car wheel published in 1915, I called attention to the question of proper deoxidation of the metal and the practicability of removing nitrogen at the same time. Experiments along these lines prove that the way already has been opened by which to product a chilled cast iron that, by comparison, not only will determine the fate of any casting not improved in the manner suggested, but it is true also that all metals which have been thoroughly deoxidized are safer, stronger, more durable and are beginning to take precedence over all other cast iron products.

Method is Practicable

The possibility of a definite and permanent standard in regard to chilled car wheels is not only something that has been proved entirely practicable, but it is now possible by such a method as the one suggested to distinguish between safe and unsafe wheels by means of this most inexpensive and most easily governed system.

Whenever this system has been tried the manufacturer has been so thoroughly convinced that no one has ever been willing to tear out the melting furnace and return to the cupola method. The old way makes a car wheel which has every external indication of modernity with no way of proving the truth on the inside except by breaking the wheel open. The new way begins at the other extremity and denudes the metal of its dangerous elements so that the only variations possible must be those due practically to the variability only of hand molding if the latter be permitted.

The iron from the air furnace necessarily is closer-grained than cupola metal since it has been subjected to a more scientific and more

positive process of refining and of limiting and of removing the impurities already mentioned. A consideration of moment and well worthy of investigation in connection with the problem is the probability that chilled wheels made by the positive analysis plan will readily carry a heavier chill. Such a result would benefit the manufacturer for two reasons: It would do away with the occasional wheel of low or high chill which now causes the rejection of all wheels of the same pour number (of the same date) and it would insure greater uniformity in mileage.

Labor Costs

Mention has been made of the principal advantages of the air furnace method, with one exception, and this, from the maker's viewpoint, may be taken as probably the chief *desideratum* — the mooted question of labor cost. The writer has made some investigations along this line in connection with a competent engineer. We found that the use of overhead traveling cranes, straight floors arranged to handle the large ladle containing say half of all the metal required for 300 wheels, pits arranged at the end of the floors to avoid every possible delay and the use of two 50 to 75-ton furnaces only, for each 300 wheels coupled with the practicability and ease of pouring the entire lot with only two to four men, thus allowing all the molders and helpers to go home after setting up their floors, would effect a considerable economy.

Foundry Cost Accounting

By W Van H Egerman

THE writer makes the observation, based upon the experience of a good many years, that whatever predominates in an industrial establishment, predominates in the minds of men when it comes to figuring the cost of the product.

For instance, in a watch factory where parts are very small and the labor is multifarious, when people talk about costs, the first thing that is in their minds is labor. In an establishment where the rent is exceedingly heavy and insurance rates are high, the first thing that is in their minds, when they talk costs, is the burden.

So, in a foundry, the first thing that is always in the minds of men is metal; the material cost, because it is the most obvious thing in a foundry.

This is to a certain point psychological, and in many cases logical, but in a foundry, it happens that it shoots beside the mark, because while metal is a very important item, it is by no means the most important one. It should, however, be taken care of first.

There is in the minds of most foundry managers a consciousness that uniform methods of foundry cost accounting should be adopted; a method that will lend itself to all contingencies as they present themselves in different localities, and one that will convey to the minds of the management accurate information as to what his products cost.

Incidentally, it might be mentioned here, that a good cost accounting system should not only do this, but that it has higher functions, and that is, it should tell the management what it costs to run the business.

If a cost accounting system tells how much a finished product costs, and if it is found that it is high compared with market conditions, the same system should also tell the management why it is high, and where it is high.

Failing in this, it lacks in the most important principle, because, naturally, a manager, who is competing with other foundrymen and loses out by reason that his bid is too high, will want to know (if he is satisfied that his competitors know what they are doing) why it is that he cannot produce castings as cheap as they can.

Bearing all these things in mind, the following method of cost accounting is offered:

We begin with the metal.

An accurate daily record should be kept of what goes into the cupola in different kinds of metal, in scrap, in fluxes and in fuels. To this is added the cost of cupola attendance, and to this is also added the shrinkage, figured at the price of total weight of metal divided into the gross cost of the metal, including fuel and fluxes. The shrinkage, of course, is not figured until after the amount of sprues and gates has been credited back to the total weight of metal.

The cupola attendance should bear its own burden, of which, more later.

This will give us the cost of the metal at the spout.

Labor and Cost

Every foundryman, if he stops to think of it, knows that the cost of his castings really lies in the labor. Up to this point, if he has two or three different mixtures of metal, the cost does not vary a great deal, but we are now at the point where the intrinsic value of the castings is going to be determined, and for the purpose of affording the management adequate means to analyze the conditions in his foundry, all the labor should be intelligently classified—productive as well as non-productive.

As far as productive labor is concerned, it should be classified under different headings that will take care, in a logical way, of all the various operations that are performed in the foundry.

In this connection, the following is submitted:

Cupola Attendance:—This should cover all labor connected with the charging of cupolas and furnaces, and should be divided pro rata weight of metal.

Molders:—This should cover all labor of men employed as molders. This should be divided by part numbers. That is to say, every piece that is made in the foundry should have a part number, and the labor spent upon them should be assigned directly to its respective number.

Molders' Helpers:—This should cover all labor that can be construed as assistance to molders, such as mixing, wetting down and fetching in sand, and all other work of this nature. This cannot always be determined by part numbers because molders' helpers may be assigned to two or three different molders, each working on a different piece. It is best to distribute this pro rata molders' labor. While this is not always the fairest way, it is, taking everything into consideration, the most reasonable way.

Coremakers:—This should cover the labor of all men directly engaged in the making of cores and should be distributed by part number.

Coremakers' helpers:—This should be distributed in the same manner as molders' helpers, that is, pro rata coremakers' labor.

Molten Metal Handling:—This should cover all the labor expended on the handling of molten metal. If molders work at piecework rates, which include their pouring their own molds, no attention need be paid to this sub-division, but if extra help is provided, or if molders work by day work, all time spent in pouring should be charged to this heading.

Rough Grinding and Cleaning Castings:—This should cover all labor expended on the cleaning of castings beginning with breaking them out of the sand. It is not always possible to assign this labor to part numbers, by

(*Continued on page* 500)

How Foundry Costs May Be Reduced By Analysis

A Critical Examination of the Outlay for Labor, Material and Equipment Will Show the Foundryman Where Economy Can Be Effected

By R E Kennedy

THERE is an old adage which says, "A new broom sweeps clean," and we always expect a man who enters a new position to make a strenuous effort to show results. When we hear some of the seemingly wonderful tales of how practicing engineers have gone into plants which were not paying or barely getting along and have made them pay good dividends, most of us are apt to credit such results to the theory expressed in the old saying. But to those who know, it is conceded that the reasons why such results can be accomplished by outsiders, admittedly not so familiar with details as the local management, are several. Not the least of them is the effect of a broad perspective unhampered by time honored traditions and methods. The fresh viewpoint of the practicing engineer gained through contact with many similar problems supplants what may have become restricted conceptions on the part of the local management.

Methods, policies and traditions are examined with unemotional care and the results of their operation shown in cold dollars and cents. If they do not produce the predicted results, they are supplanted by those that will. The process is one of elimination and constructive rebuilding. In the end only the efficient survives. Not all of the old methods are bad—on the contrary, many are very effective. The consulting expert does not sweep them all away, but rebuilds a new structure on the old foundation. The local organization can do the same thing if it knows how—and it should know how if it is composed of men of the right caliber. Daily contact with the grinding details that beset every foundry operator makes it difficult for him to see beyond these details. If he does not take care, he will be looking at his business through the wrong end of the telescope. Then the small things become unduly important and the larger questions of policy may escape notice altogether.

The successful foundry operator knows that efficiency begins at the top and works down—that efficiency in the shop is the result of efficiency in the office. He knows that the best materials, the most effective methods and an organization of skillful workmen do not just happen. On the contrary, he realizes with the keenest appreciation that these things follow only upon the dictation of the directing forces.

Foundry operation, like practically all manufacturing, is a problem involving three factors, namely, labor, material and equipment. Each of these factors presents its own special problems, but as they are distinct in character, control is accomplished in a simple manner by dividing responsibility among members of the supervisory staff according to fitness and experience. No one man can be an expert in all lines and it is not good practice to shoulder upon one man a large variety of duties that he is not fitted to carry. Modern organization calls for specialists—each supreme in his own special field. Such a plan centralizes responsibility in the hands of thoroughly competent men who reduce costs by eliminating waste.

A critical examination of the principal operating factors should be the daily program of the foundry manager. A few hints as to the direction which this examination should take are indicated hereafter. We will take up a discussion of each of the three factors in the order of what we consider to be their importance. Labor is considered to be the most important because without the right kind of labor and its proper supervision, good material and equipment would go for naught.

You will often see two factories, situated almost side by side, manufacturing the same line of goods, with the same kind of equipment—yet the quality of the work will be vastly different. This difference will almost invariably be traced to workmen, but the blame will have to be placed on the foremen or superintendents, for the workmen will produce the quality of output demanded of them or, if they do not, the right executives will either train their men to do better work or eliminate them and get others who will. Where slipshod work is tolerated, there you will find a tendency for all the workmen to turn out slipshod work and when the best is demanded, you are sure to find the best. The whole question, then, of quality of output rests practically altogether with the management. It behooves the management, therefore, to be strict in its demands and alway on the lookout for ways and means of keeping the quality and quantity of the product as near perfection as it is possible to go. The maintenance of labor standards means a constant study of men and their methods of doing the work they have been

FORM 102

B2 4 **INSTRUCTION CARD**
SHOP LABORATORIES
FOUNDRY DEPARTMENT

FLOOR BENCH MACHINE STATION 3

STANDARD FLASK NO
SPECIAL FLASK NO
CORE BOX NO CORE PLATE NO
SAND MIXTURE NO
WIRE SIZE RODS SIZE
NO. LOOSE PCS NO CORES

TOOL KIT NO
RAMMER
FACING MXT. NO.
TACKLE No 2 Shovel No 4 Wheelbarrow No 8 21" Riddle

PART *FACING MIXTURE N°8*
ARTICLE PATT. NO.

ITEM	OPERATION ROUTINE	STANDARD TIME
	NOTE. CARD MADE FOR EIGHT (8) WHEELBARROW LOADS IF A LARGER BATCH IS NEEDED, USE QUANTITIES OF MATERIALS IN SAME PROPORTION	
1.	FROM SAND BIN NO 2 OBTAIN THREE (3) WHEELBARROW LOADS OF SAND AND TAKE TO MACHINE NO (4) DUMP INTO MIXING BOX...	.10
2.	FROM SAND BIN NO. 5 OBTAIN FIVE (5) LOADS OF SAND TAKE TO MACHINE NO.(4). DUMP INTO MIXING BOX.....	.20
3.	FROM STORAGE ROOM NO. (2), BIN NO (3), OBTAIN ONE LOAD OF SEA COAL. TAKE TO MACHINE AND DUMP INTO MIXING BOX.....	.05
4.	MIX SAND AND COAL BY CUTTING THROUGH PILE WITH SHOVEL ONCE.....	.05
5.	ADD TWO (2) BUCKETS OF WATER AND RUN THROUGH MIXER.....	.15
6.	SHOVEL INTO SAND BIN NO.(1).....	.08
	TOTAL STANDARD TIME	.63

FIG. 1—INSTRUCTION CARD FOR THE GUIDANCE OF UNSKILLED LABOR

A paper read at the American Foundrymen's Association convention at Cleveland, Sept. 11-15.

UNIVERSITY OF ILLINOIS
SHOP LABORATORIES
ALL DEPARTMENTS

MATERIALS STOCK RECORD

MATERIAL PART
BRAND ARTICLE
SPECIFICATIONS COMPOSITION
WEIGHT FIN. ____ LBS ROUGH ____ LBS COST ____
MADE BY
PURCHASED FROM

STOCK NO
PATT NO
MAX REQ
MIN REQ
MARK

AM'T REQUIRED			AM'T ON HAND	BALANCE		ORDERED		RECEIVED		ISSUED	
ORD NO.	DATE	AM'T		SHORT	OVER	DATE	AM'T	DATE	AM'T	DATE	AM'T

FIG. 2—MATERIAL RECORD USED FOR KEEPING A CONTINUOUS INVENTORY OF ALL STOCK

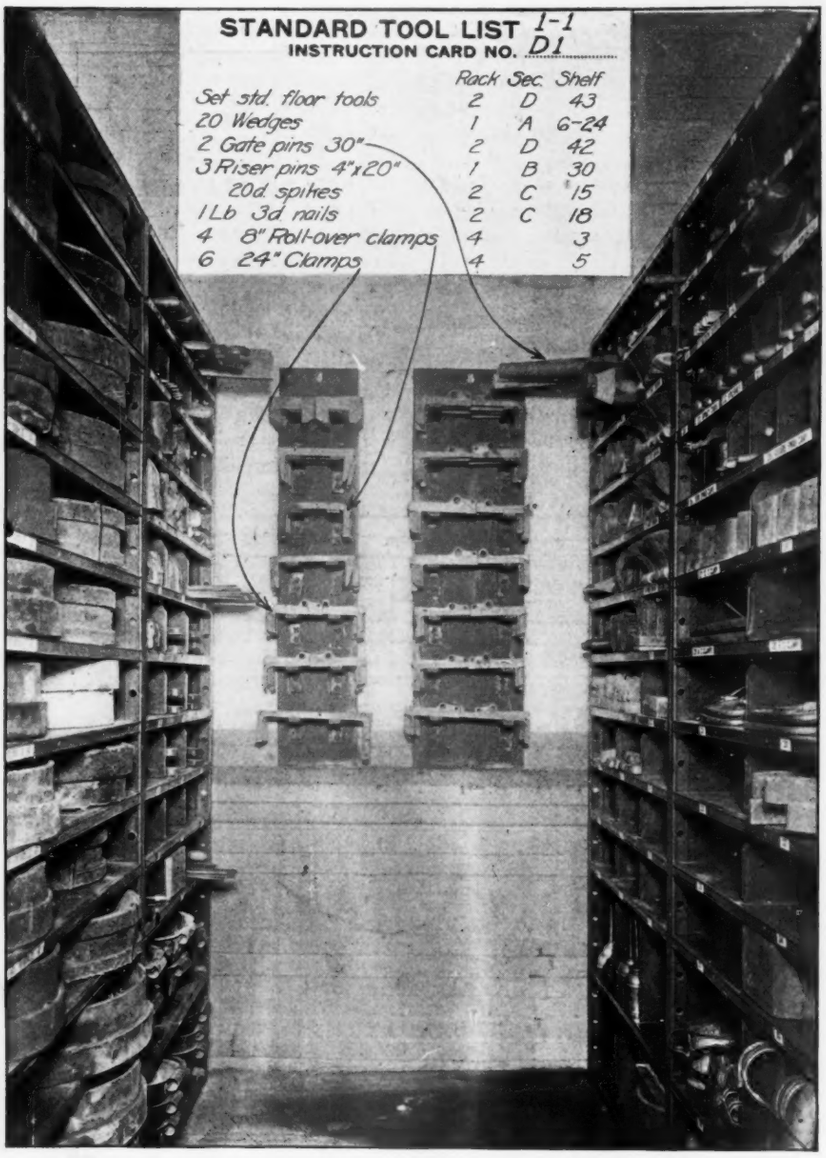

STANDARD TOOL LIST 1-1
INSTRUCTION CARD NO. D1
Rack Sec. Shelf
Set std. floor tools 2 D 43
20 Wedges 1 A 6-24
2 Gate pins 30" 2 D 42
3 Riser pins 4"x20" 1 B 30
20d. spikes 2 C 15
1 Lb 3d nails 2 C 18
4 8" Roll-over clamps 4 3
6 24" Clamps 4 5

FIG. 3—VIEW OF A PART OF A FOUNDRY TOOL ROOM SHOWING ACCESSIBILITY OF EQUIPMENT

given to do. It is well known that there are many ways of doing any one piece of work, but many forget that there is only one best way and no one has yet put into practice that best way. A few seem to have reached this best way, but the greater majority, while still far from the goal, are content to rest on their oars and follow the method taught them a long while ago.

Value of Time and Motion Study

In foundry work there is no general way of determining whether the method in use is the best, and the common thing to do is to put a man on the job and let him go to it, the amount of advice given him being very small compared with the amount of valuable instruction which could be given.

The changing of methods is, as a general rule, a slow process of evolution, the changes being suggested from time to time by certain circumstances brought to light mostly by chance. During recent years, due to the change of work and competition, it has been necessary for many shops to make thorough analyses of their operations to hasten improvements in methods and equipment. For these analyses, time and motion studies of the different classes of work have been made and it has been found that such a study, scientifically conducted, shows up the following factors:

1.—The improvement that can be made by the management in the conditions, equipment, and shop organization, to help the operator improve the quality and increase the output of his work.

2.—The work done by the operator which is unnecessary and by eliminating which the operator can turn out more product of as good a quality in the given time, without any more exertion.

Time study, when rightly applied, means the hastening of these changes because of the facts brought to light by scientific study of the conditions. These studies should be made by someone familiar with the local shop methods, familiar with the best practices in this line of work in other shops and one who will not let himself be held to the traditional shop method just because it had been customary to do the work in one certain way in the past.

Also, changes must not be made just because they have been made in other shops, but a careful detailed analysis of all the work being performed in the shop must be made and after thorough study of the probable results it is determined whether the changes will benefit the shop.

In considering the materials used, the foundryman will first have to investigate his needs thoroughly. The question will have to be asked concerning each material item, "What is the real need in this case?" It might be possible to

entirely eliminate the blacking of cores in certain cases if the sand were changed. Is the molding sand used giving as good results as that used by the most successful foundries in this line of work? Perhaps the castings would be selling better if a sand giving a smoother surface were used. Very often, the core sand in question is being used because it has been customary to use it in past days and no one has suggested a change, or perhaps it is a cheap local sand and the foundryman hesitates about paying more for a sand from a distance. In one large Wisconsin foundry, the core-room foreman found that he was enabled to entirely eliminate the use of core dryers by using a different sand.

Are the binders used really the best for the purpose of the shop or quality of casting to be produced? The use of an oil binder with an open sand frequently will do away with all venting. The writer remembers a particularly striking example of unnecessary venting which was due to lack of knowledge. In a foundry, supposedly modern, a binder was being used on certain waterjacket cores which made it necessary for the coremaker to spend 20 minutes venting each set of cores. The binder was changed to an oil compound and quartz sand mixtures which, though slightly more expensive, saved more than twice the entire expense of the binder by eliminating the venting. At the present time, many core-makers are spending needless time venting certain oil cores because no one in the foundry has taken the trouble to ascertain whether the venting can be done away with.

Eliminating Dryers

In other cases, a different sand and binder frequently does away with the use of dryers or will give more perfectly shaped cores. The best foundry practice is to use just enough core binder to hold the core sand together until the casting has set. If too much is used, the hard core requires extra work to remove it from the mold, therefore, the proper mixture for different sized castings and kinds of metal should be determined. The shops which do not have their sand mixtures standardized are the most frequent losers because of excessive binder.

The lack of enough binder and the subsequent loss of cores in handling is also due to failure to standardize the mixture. Using the best binder and sand, mixing them in the same way each time and baking them under the same conditions will produce the results wanted. Core sand and facing mixture standards are placed on cards, as shown in Fig. 1.

In the case of cupola supplies, it is a question of obtaining cupola blocks and clays of the best quality, for here, as in nearly all other cases connected with the purchase of materials, it is a paying proposition to get the best. The money saved by the use of inferior, cheap grades will be more than offset by the expenditure of money caused by the amount of extra labor used in relining the cupola at more frequent intervals.

Some form, such as the material record shown in Fig. 2, can be used not only for keeping track of the amount of material on hand, but has a place for the entry of a specification for the buying. With this specification, made out according to the best information obtainable, the materials should give satisfaction. The writer has found it to be common foundry practice to order minor foundry materials without any specification as to quality, which is as bad as a similar practice of ordering pig iron without specifying the chemical content.

Molding sand is another material to which a lot of thought should be given. Many foundries are purchasing the same kind of sand from year to year without really knowing whether it is the best and cheaper when everything is considered.

It is very desirable that foundrymen keep a record of the weight of castings produced for each ton of sand used.

FIG. 4—VIEW OF A CORE ROOM FITTED WITH WELL EQUIPPED BENCHES WHICH TEND TO MAKE THE COREMAKER'S WORK MORE EFFICIENT

Are many castings being lost by scabbing which would not occur by the use of a different sand? We all acknowledge that the best of molders can produce castings using any old sand, but does not the less skilled molder or machine hand have more trouble with scabbed castings? Changing the molding sand has often reduced the loss of scabbed castings, turned out by semi-skilled molders, to a minimum. It takes only a few bad castings to make some apparently cheap sands very dear in cost.

The necessity for giving strict attention to the purchase of materials cannot be given too much emphasis, for materials that require extreme care in handling will require very skilled men in their manipulation and skilled labor costs more than unskilled. We do not think anyone will advocate the use of this kind of material when castings of as good a quality can be produced at less cost by using cheaper material and labor. In these days, when inexperienced men have to be used, it is a better policy to place in his hands such materials as he can work with satisfactorily with the assurance that he will produce good results. From this can be seen the importance of having men at the head of the shop who are skilled enough, and who will analyze the results and can place the blame where it belongs.

Not the Fault of Cores

Once when the writer was working as a coremaker in a large engine plant, many small castings of a certain type were lost and the foreman of the foundry claimed that the cores blew. The core-room foreman, not knowing much about molding, had to take his word for it, but the writer investigated the case and found out that the castings did not have a head of metal high enough to force and hold iron in the projecting part. The molding practice was changed. The foundry foreman either did not know enough to analyze the cause or, not caring to take the blame, tried to make the core-room foreman the goat.

Shifting the Blame

This same habit of always trying to place the blame on the other man, thus dodging personal responsibility, is one of the worst faults of most foundrymen as well as men in other lines of work. The organization of an efficient inspection department with men having a good knowledge of foundry practice will eliminate these troubles by carefully analyzing all losses.

PATT NO. 1-21 SEC C SHELF 4

CORE BOX NO 1-21.1 NO OF PARTS 2

NAME Intake pipe elbow

IN FOUNDRY		IN PATTERN STORAGE		IN REPAIR SHOP	
SIGNATURE	DATE	SIGNATURE	DATE	SIGNATURE	DATE
R.E.K.	3/6/16	G.A.G	3/9/16	V.S.Day	3/7/16
J.A.H.	5/14/16	J.M.D	5/18/1916	V.S.Day	5/17/16
J.A.H.	6/3/16	G.A.G.	6/3/16	V.S.Day	6/3/16
R.E.K.	6/10/16	G.A.G	6/12/16	V.S.Day	6/11/16

FIG. 5—RECORD USED TO LOCATE PATTERNS AND CORE BOXES

In the matter of equipment, much has been done in the last few years to improve foundry conditions through the application of molding machines, sand cutting and mixing equipment and transportation and conveying systems, and most foundrymen have taken advantage of some or all of these means to increase their output. These devices all require considerable outlays of money and before making an installation, a study should be made of the advantages to be gained, determining what machine will best fill the particular needs at hand. In most cases, the answer is determined by the number of castings to be made from different patterns.

Those machines which are simple and permit of easily changed patterns are of most value to ordinary shops. Among such machines are the ordinary hand or air squeezer, the simple roll-over drop plate, and the straight stripping plate machine. Very few foundries are doing work of such a nature but that it will pay them to investigate the possibilities of installing some of the simpler molding machines. In foundries having exceedingly large orders, the more complicated machines that combine several operations and the installation of elaborate sand handling plants are important factors.

Nearly every shop will find that it pays to have simple electric riddlers and sand mixers, for these machines will supply the molders with a thoroughly riddled sand and facing at a great saving in labor. Also there is a saving in the amounts of sea coal and core binders used, as compared with hand-riddled sand. The use of these mixers will assist the foundryman in standardizing his methods of mixing. It certainly is surprising how often we still meet foundry foremen who, without giving the matter real thought, declare that such machines are no good, believing they know it all and not caring to have others teach them anything.

It also is necessary, in order to get real value out of machines, to keep them in use and not let them lie idle any more than is absolutely necessary. An example of the losses accruing from idle machines was found in the foundry of a well known automobile factory. There were six molding machines in the brass department, which were used merely as ordinary molding benches with vibrator attachments. Although most of the work in this department was of a type almost ideal for squeezer machines, it was not fitted up on plates for use on these squeezing machines. There were 20 other machines in the gray iron department of this shop stored, or rather dumped, in storage bins and only two machines were in use on the cylinders, although good use was being made of rock-over machines for core work. The difficulty seemed to be that the foreman, having a little trouble in getting the squeezing machines and plates fitted up as they should be, got disgusted and turned back to the old way of doing the work.

Uniformity Desirable

Where possible, the make of machines should be kept as uniform as possible, for this means fewer kinds of pattern fixtures, greater interchangeability of work and all machines in use all the time.

Another important item to consider in foundry equipment is that of flasks. In only a few cases do the old wooden

flasks pay, for their weakness and short life make them the most expensive in common use.

It is up to the foundry management to decide whether they want steel, iron or wood flasks, and careful consideration should be given to finding out what is best for any particular shop. The question of investment, absolute accuracy of flasks, ease in handling, standardization of pins, and length of service, are some of the things to be considered by the foundryman in studying this item.

The foreman who is a constant reader of foundry literature, learning of the kinds of new equipment being put on the market, is the one who is most apt to keep his shop on the best paying basis. The one who merely stays in his own shop, without seeking outside information, is the man who lets the world march on and then suddenly wakes up to find himself out of the running.

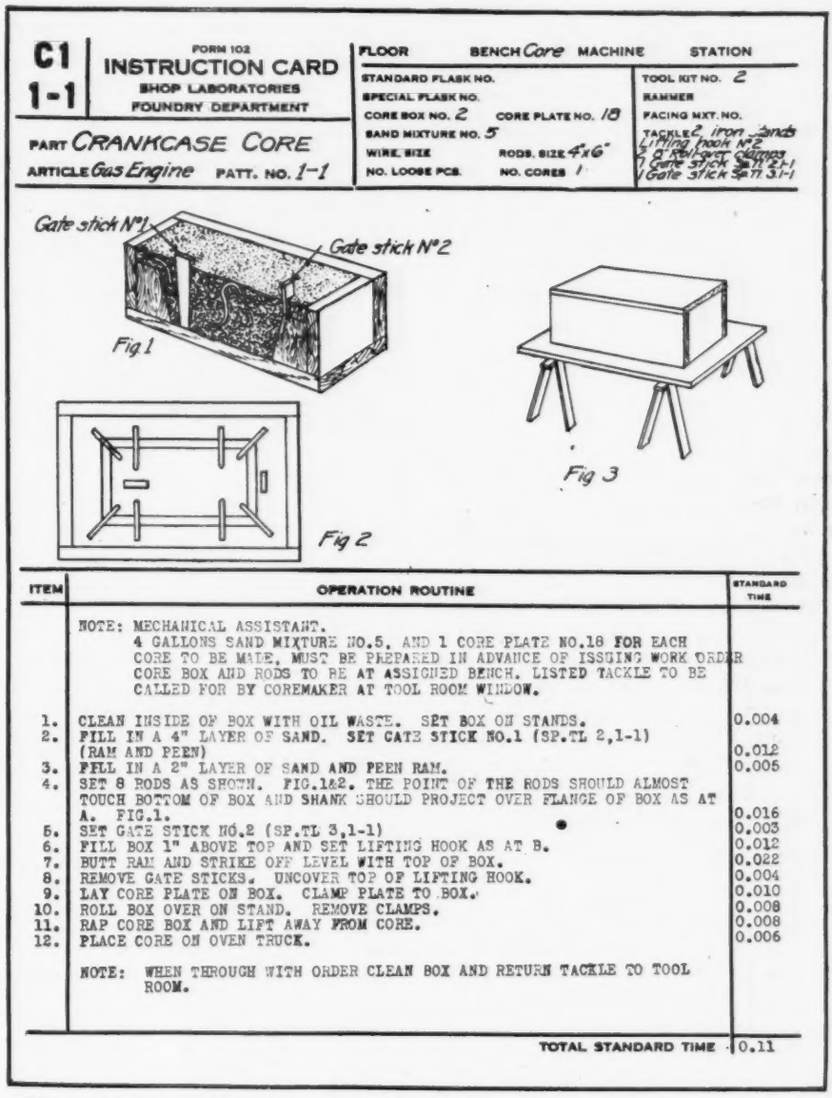
Machine Upkeep

The proper equipment having been installed, it is necessary to watch closely and have it always in running order. Flasks and boards should always be kept in shape and all repairs should be made as soon as possible. To be sure that this is done, it will pay to have some one man charged with the upkeep and make him responsible.

Molders, coremakers and other foundry help, as a general rule, know very little about the proper care of machine tools and cannot be depended on to see that the mechanical equipment is cared for in the proper way. Because so many foundrymen lack this training in machinery upkeep is all the more reason for having some machinist whose sole duty it is to keep the mechanical equipment in the best of condition. We all know that good machinery in good condition is one of the best paying propositions in any line of manufacture, and good machinery neglected is one of the most costly items in a shop, for it is money being thrown away.

Very few foundries have even a semblance of a tool room and yet the slogan, "The right tool in the right place when wanted", could be of value to every foundry as it is to practically all machine shops. Almost every person who has worked in foundries has seen the constant hunt for such tools as levels, hatchets, trammel points, special clamps, gaggers and many times for decent riddles, rammers, shovels and many of the most common tools.

A molder, when first starting to work in a shop, usually brings in a few tools of his own and inherits from the man who previously worked his floor some old tools, such as a shovel, a rammer, gate pins, etc. Each molder is generally fighting to retain possession of sufficient gaggers, clamps and wedges for his own needs and frequently has to use makeshifts. Usually when he is through using clamps and special equipment, he will hide it away for future use, and if, in the meantime, another man has need for it, it is not unlikely that it cannot be found.



C1 1-1 — FORM 102
INSTRUCTION CARD
SHOP LABORATORIES
FOUNDRY DEPARTMENT

FLOOR BENCH Core MACHINE STATION

PART CRANKCASE CORE
ARTICLE Gas Engine PATT. NO. 1-1

STANDARD FLASK NO.
SPECIAL FLASK NO.
CORE BOX NO. 2 CORE PLATE NO. 18
SAND MIXTURE NO. 5
WIRE, SIZE RODS, SIZE 4x6"
NO. LOOSE PCS. NO. CORES 1

TOOL KIT NO. 2
RAMMER
FACING MXT. NO.
TACKLE 2 iron bands, Lifting hook N°2, 2 C Rail joint Clamps, 1 Gate stick N°1 2-1, 1 Gate stick N°2 11 3-1

Gate stick N°1
Gate stick N°2
Fig 1
Fig 3
Fig 2

ITEM	OPERATION ROUTINE	STANDARD TIME
	NOTE: MECHANICAL ASSISTANT. 4 GALLONS SAND MIXTURE NO.5, AND 1 CORE PLATE NO.18 FOR EACH CORE TO BE MADE, MUST BE PREPARED IN ADVANCE OF ISSUING WORK ORDER CORE BOX AND RODS TO BE AT ASSIGNED BENCH. LISTED TACKLE TO BE CALLED FOR BY COREMAKER AT TOOL ROOM WINDOW.	
1.	CLEAN INSIDE OF BOX WITH OIL WASTE. SET BOX ON STANDS.	0.004
2.	FILL IN A 4" LAYER OF SAND. SET GATE STICK NO.1 (SP.TL 2,1-1) (RAM AND PEEN)	0.012
3.	FILL IN A 2" LAYER OF SAND AND PEEN RAM.	0.005
4.	SET 8 RODS AS SHOWN. FIG.1&2. THE POINT OF THE RODS SHOULD ALMOST TOUCH BOTTOM OF BOX AND SHANK SHOULD PROJECT OVER FLANGE OF BOX AS AT A. FIG.1.	0.016
5.	SET GATE STICK NO.2 (SP.TL 3,1-1)	0.003
6.	FILL BOX 1" ABOVE TOP AND SET LIFTING HOOK AS AT B.	0.012
7.	BUTT RAM AND STRIKE OFF LEVEL WITH TOP OF BOX.	0.022
8.	REMOVE GATE STICKS. UNCOVER TOP OF LIFTING HOOK.	0.004
9.	LAY CORE PLATE ON BOX. CLAMP PLATE TO BOX.	0.010
10.	ROLL BOX OVER ON STAND. REMOVE CLAMPS.	0.008
11.	RAP CORE BOX AND LIFT AWAY FROM CORE.	0.008
12.	PLACE CORE ON OVEN TRUCK.	0.006
	NOTE: WHEN THROUGH WITH ORDER CLEAN BOX AND RETURN TACKLE TO TOOL ROOM.	
	TOTAL STANDARD TIME	0.11

FIG. 6—INSTRUCTION CARD—A TIME SAVING DEVICE WHICH ANTICIPATES PRECAUTIONS IN ADVANCE OF PRODUCTION

What molder, coremaker, or foundry laborer would not appreciate a good tool room and a storage place where tools and equipment could be obtained when needed?

With a central storage place, tools and equipment can be kept in repair and on hand in sufficient quantity for the needs of the shop. When a workman is through with special equipment, such as gaggers, clamps, riser pins, blocks, etc., it could be returned by someone whose duty it is to collect such things. Other tools, such as the more valuable special lifters, wrenches, levels, hammers, etc., could be checked out on the ordinary checking system. Fig. 3 shows some views in a foundry tool room, which has proved to be a decided success.

Even in highly specialized shops there is need of this central tool room together with supervision over the tools used, for very few molders really analyze their needs to the best advantage. Much time could be saved if all the workmen were supplied with the best small tools for their class of work, for there are few foundries in the country where there is not seen a great variety of swab pots, lifters, slicks, vent wires, gate cutters, draw screws, etc. In this large variety of tools there are many which are inefficient and should be discarded.

In foundries with a great variety of work, the need for a tool room for the storage of the great variety of special equipment used is much greater and it is just as bad practice for a foundry

to not have such a place as it is for machine shops to have no storage room for their jigs, gages, and other fixtures and small tools.

Listing Tools Needed for a Job

It is becoming more and more impressed on foundrymen that before a piece of work is turned over to the workmen, it should be carefully considered by a planning department to see the proper flasks, boards, rods, gate and riser pins, facing sands and methods of making are placed in the hands of the molder before he starts to work.

This idea may be carried out further by having this information placed on a form and filed away for future use. This record will be of invaluable assistance to those having charge of the planning in the shop. Fig. 3 illustrates a tool card that can be used to advantage by any foundry. Fig. 6 shows an illustration of an instruction card for use in coremaking and coremolding.

To make such a scheme effective, organization of the shop forces is necessary, so that when an order reaches the foundry office, the production manager can turn the information, as to when and where the work is to be made, over to the mechanical supervisor. Then from the tool cards, the mechanical supervisor finds out what is needed for the work in the way of tools and equipment and has everything ready to start work at the proper time, without the necessity of having the molder or coremaker loaf around while some needed equipment is being found or made. Such a system also avoids having to hunt for some missing part or tool.

Summary Analysis Procedure

When a foundry is in difficulties from the manufacturing end, the solution can nearly always be found from a study of one or all of the three factors which have been discussed. These factors having been analyzed in the light of the best in the foundry world, the causes of poor results should be ascertained. Knowing where the trouble lies, it is generally a comparatively easy matter to remedy the cause, but the remedy cannot be applied before the cause of the trouble is located. It is necessary, to get the best results, to take action along the following lines:

1.—Study the methods in vogue in the shop in question.

2.—Study the methods in vogue in the best practice in this line of work, or any other line of work which might suggest ideas.

3.—Clean up the shop and arrange it for the best work, providing storage places for equipment and materials.

4.—Standardize materials, mechanical equipment, methods, and times of operations.

5.—Route and dispatch work through shop under these improved conditions.

By standardization, we do not mean that one certain method or piece of equipment should be selected from the many and then adhered to religiously forever, but we do mean that the best known way should be found and then used as a standard, while a constant search is being carried on for a better standard. We all know that standards are being raised all the time and are expensive to change, therefore, the firm which can set its standard further in advance of the others will find it unnecessary to change the standard as often as the others. Also, it is well known that those manufacturers having a definitely outlined course of procedure will almost always succeed,

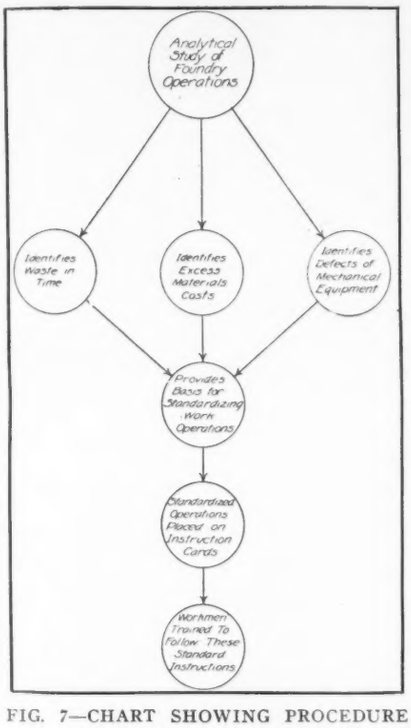

Analytical Study of Foundry Operations
Identifies Waste in Time
Identifies Excess Materials Costs
Identifies Defects of Mechanical Equipment
Provides Basis for Standardizing Work Operations
Standardized Operations Placed on Instruction Cards
Workmen Trained To Follow These Standard Instructions

FIG. 7—CHART SHOWING PROCEDURE IN ANALYZING AND CHANGING SHOP CONDITIONS

when often they would fail under the old hit-or-miss system.

The larger and more specialized foundries have had most of these ideas of standardization forced upon them by the hard school of experience. They have been compelled to use comparatively unskilled help, and have been obliged to train this help in the execution of specialized tasks, such as machine molding, sand mixing, pouring metal, etc. Before much can be done in the way of planning and dispatching work through a foundry, the average shop will have several important things to do. First, it will have to be cleaned up. Get rid of the accumulated junk so often found in corners, gangways and bins. Storage places will have to be provided for all equipment and materials and methods devised for keeping track of this stored equipment and materials. Moreover, these storage places should be arranged in the most accessible places with men in charge to see that the equipment and materials are kept in their proper places. The arrangement of the foundry shold be such that the work proceeds in a steady flow from the raw material yard, through the core and molding rooms to the cleaning department.

With the shop in good condition, an effort can be made to standardize the operation routines and set rates on the different pieces, with some assurance that the rates will be correct.

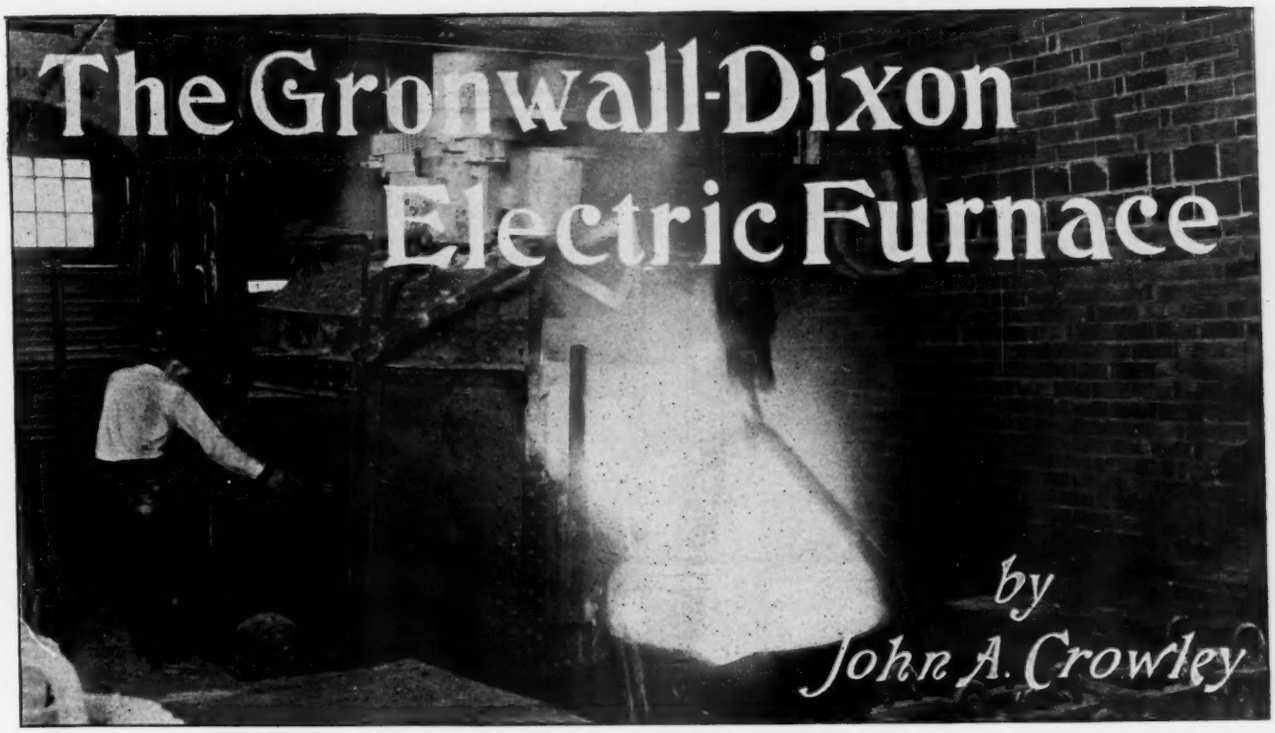
These rates should not be set by estimates by the foreman, but should be made by time study averages. It is true that the average foreman's estimate of the time needed to do a given piece of work is seldom accurate. When all operations are proceeding in good form, it still remains for the manager and all men working under him, to strive constantly to improve methods and results, for the manufacturing world is continually moving ahead and those who stand still are soon out of the running.

Castings in Iron Molds

By W. J. Keep

Question:—We note from your answer to our recent question regarding permanent molds that you state the molds should not be allowed to become hotter than 450 degrees Fahr. This will be rather hard to determine and we would like to know if water jacketed molds could be used to good advantage. We would like to know if the analysis which you gave is for castings which are to be machined after they have been cast in permanent molds. The castings which we contemplate making will not have to be machined. We also would like to know why the carbon should be as high as you state. What effect does this have? The analysis of the iron which we are now using, follows: Silicon, 2.65 per cent; sulphur, 0.078 per cent; phosphorus, 0.69 per cent; manganese, 0.61 per cent, and combined carbon, 0.50 per cent.

Answer: — Four hundred and fifty degrees is not red hot. If you shake-out the castings as soon as they are set, the mold will not get too hot. Water-jacketed molds are expensive and are not as easily handled as air-cooled molds. You can machine castings of the composition you now use. If you do not wish to machine the castings, reducing the silicon will harden them. The mixture given was taken from the Specifications of the American Foundrymen's Association and the carbon content was found by analyzing the castings sent to the committee.



OVER a year ago the first Gronwall-Dixon electric melting and refining furnace was installed at Detroit. In conjunction with the basic Gronwall patents, there were combined certain American patents secured by Joseph L. Dixon. The Gronwall-Dixon furnace operates on a 2-phase system, energy being taken from 3-phase supply through two banks of transformers connected by a modified Scott 3-phase to 2-phase connection. In units of five tons and larger capacities, four vertical electrodes are introduced through the roof. The bottom electrode is embedded under the lining of the hearth and is entirely protected from the molten charge. It therefore requires no water cooling. In capacities smaller than five tons, two electrodes are introduced through the roof.

Under the Gronwall-Dixon patents, the transformers are arranged to deliver a current at varying voltages, which are immediately available as required by the operator. Each phase of the two-phase current, which takes a balanced load from the three-phase supply mains, is carried to a pair of the vertical electrodes, the bottom electrode being joined to the neutral point of the transformers.

Arcs Can Be Thrown in Series

Through a special arrangement of switches the arcs can be thrown in series, or in parallel or into several series-parallel positions. During the melting stage, while the arcs are in series, the lower electrode greatly accelerates the process by carrying a considerable proportion of current, as well as all the unbalanced loads, which in commercial operation are unavoidable. Because of this feature, the power input to the furnace may be greatly increased over and above the amount it would be possible to carry without the bottom electrode. In subsequent periods of refining, recarburizing and introducing alloys, or for holding the bath, the voltage can be reduced, shortening the arc, thereby lessening to a marked degree the reflected heat on the walls and roof. This procedure prevents rapid destruction of the refractories. When operating with a short arc the parallel or one of the modified connections are used, passing a large proportion of current through the bath to the bottom electrode. By this method the proportion of current flowing through the lower electrode can be varied within wide limits. From the power companies' point of view this transformer and connection arrangement makes a highly desirable load. The transformer efficiency is 98 per cent or over, the power factor is 92 to 97 per cent and the service mains and power station are not disturbed by any serious surges. Small surges that occur during the melting period are absorbed by the interlocking of the phases by the transformers.

The Gronwall-Dixon furnace is cylindrical in shape and of the usual tilting type. The tilting operation is carried out through worm driven connecting rods operated by motor drive through a reversing controler. The furnace is designed with two doors front and back. The front door is a combination pouring and charging door, the spout being removable. The use of two in place of three doors, as is customary on electric furnaces, reduces the heat losses.

Roof is Removable

The roof is built up in a supporting ring from regular and special shapes of silica brick. The entire roof is removable and by providing a spare roof, very little time is lost in replacing, in case one is burned out.

The electrodes are carried by an overhead support made up of I-beams. Their weight is taken up by a counterbalance to which the mechanical gearing for the control is attached. This control is operated by an individual motor for each electrode, which is energized through a system of contactors located on the switchboard, either automatically or at a hand-operated push button station. Instruments for indicating the amount of current and voltage in each electrode are placed on a separate panel adjacent to the control and under immediate observation of the operator. The amount of current to be passed through each electrode can be set at a number of different steps by the operator. The current will be maintained at such point by the automatic control. All levers for operating the switches are brought to a panel so that the entire operation of from one to four furnaces may be carried out by one

A paper presented at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11-15, 1916.

melter and his assistant. The furnace installed at Detroit for the John A. Crowley Co. is of five tons capacity. Up to Aug. 1, over 800 heats of alloy steel for automobile and aeroplane construction had been poured. The results obtained have been so encouraging from both a commercial and a metallurgical viewpoint, that an additional 10-ton unit is now being installed and arrangements for still further additions have been made. The operation of this furnace is continuous. The cold charge, consisting of various kinds and grades of scrap, together with a percentage of pig iron, is charged into the furnace and from this material heats of high-grade nickel, chrome-nickel, chrome-vanadium, high silicon and high manganese, high carbon and high speed steels may be made within a period of four to five hours, with an energy consumption of from 500 to 600 kilowatt hours per ton. Under favorable conditions many heats of steel refined to under 0.02 per cent sulphur and phosphorus have been completed in a little over three hours with a minimum energy consumption of 460 kilowatt-hours per ton. In making the above grades of steel, practically 90 per cent are to carbon specifications, requiring generally considerable recarburizing of the bath as well as the addition of the necessary alloys. The specifications are in all cases exacting, and the charge must be held in the furnace while a sample is analyzed for carbon, by the combustion method, manganese, nickel, chromium and vanadium, according to the grade of steel made. The above figures on power consumption include the time and energy consumed while the laboratory work is being completed.

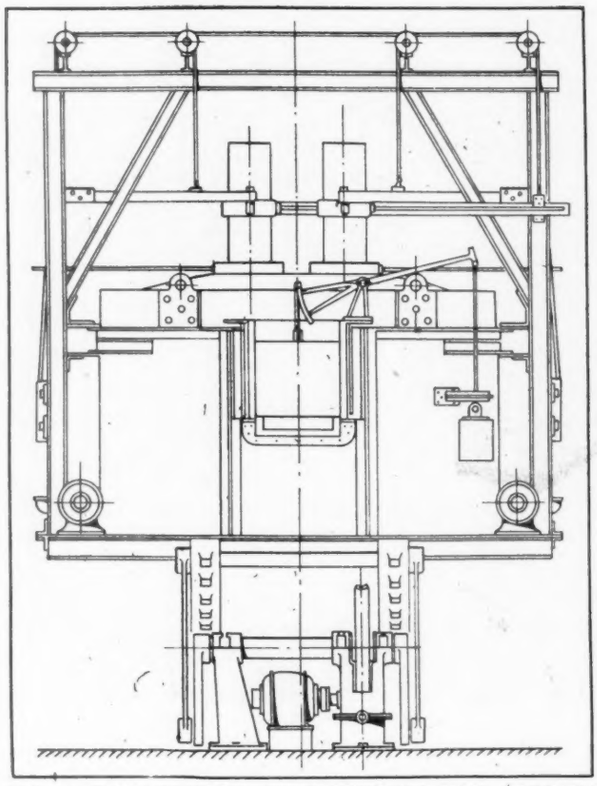


FIG. 1—CROSS-SECTION OF GRONWALL-DIXON ELECTRIC FURNACE

The estimated cost per ton of liquid alloy steel, refined to under 0.025 per cent sulphur and phosphorus, produced in a 5-ton Gronwall-Dixon electric melting and refining furnace is shown in an accompanying table.

In making the usual run of steels it has proved to be unnecessary to use any deoxidizing agents such as ferro-manganese or ferro-silicon except as required to meet the specifications. Many heats have been poured where no additions of these elements were made. Owing to this neutral atmosphere it is possible to add the greater part of the required alloys either with the scrap or immediately after the charge is melted, reserving only sufficient for a final adjustment of the analysis. Investigations of alloy steels made under this practice have shown an absolute uniformity and extreme accuracy in meeting specifications. After the melting operation, and during the refining, the passage of the current through the molten metal creates a magnetic movement of the bath producing three distinct results.

First.—It brings the entire bath in direct contact with the refining slag, materially assisting in removal of the sulphur and phosphorus. It is, therefore, possible, starting with a charge averaging as high as 0.10 per cent in sulphur and phosphorus, to reduce these elements with one slag to under 0.03 per cent. Frequently the phosphorus and sulphur have been reduced to 0.01 per cent with an additional slag. Extensive investigations of more than 800 heats have shown a minimum of segregation even in the piped section of bottom poured ingots.

This rapid reduction of the sulphur and phosphorus is also brought about by the passage of the current through the bath as it overcomes the tendency for the arcs to skim along the surface of the slag by drawing them directly into it. This method produces an exceptionally high temperature, particularly desirable when introducing the desulphurizing slag, which must be made highly basic and still kept sufficiently fluid to complete the removal of the sulphur. As there are no oxidizing gases present, the sulphur is held in the slag.

Second. — This motion of the bath brings all of the charge under the direct influence of the arcs, and cold rings at the edge and chilled bottoms have never been experienced during the operation of the Gronwall-Dixon furnace in nearly 800 heats. It is

Cost Per Ton of Liquid Alloy Steel Produced in Gronwall-Dixon Furnace

Electric energy 550 K. W. H. at 0.08c	$4.40
Electrodes, 20 lbs. at 5½c per lb	1.10
Refractories	.40
Alloys*	.94
Slag mixture—60 lbs. lime per ton of steel; 6 lbs. fluorspar per ton of steel; 10 lbs. anthracite coal per ton steel	.25
Scrap and iron	14.00
Skilled labor	.70
Unskilled labor	.30
Total	$22.09

*To raise the manganese content 0.30 to 0.40 per cent from 38 to 50 lbs. of 80 per cent ferro-manganese are added in a 5-ton furnace, or approximately 9 lbs. per ton of steel. At 8½ cents per pound the alloy addition cost is 76 cents. To bring up the silicon content in the steel, to approximately 0.15 per cent it is customary to add 6 lbs. of 50 per cent ferro-silicon which at 3c per lb. makes the cost 18c.

Conversion Costs Per Ton of Steel Castings

Electric energy, 500 K. W. H. at 0.08c	$4.00
Electrodes, 20 lbs. at 5½c lb	1.10
Refractories	.40
Alloys—See note at foot of previous table	.94
Slag Material	.25
Scrap and Iron	12.00
Skilled Labor	.60
Unskilled Labor for charging and handling scrap	.12
Total	$19.41

therefore possible to pour all of the metal, leaving the furnace entirely clean for the succeeding heats.

Third.—This magnetic action of bath produces a distribution and amalgamation of all the added alloys. This is particularly noticeable when making final additions for the adjustment of the analysis, such as metal for recarburizing, ferro-manganese, nickel, chromium or vanadium, as may be required, after which additions the furnace can be tapped within 10 minutes. That this passage of the current through the hearth is of decided benefit is shown by the fact that the initial lining installed when the furnace started, nearly a year and a half ago, is still in good condition, and gives promise of lasting an indefinite period. Another field for this furnace is the electric refining of cupola metal. Some of the results have been most encouraging. In one case, fluid metal was taken from the cupola and refined in the electric furnace, the resultant metal indicating remarkable physical properties when tested in the form of a test bar. The final analysis of the iron from the furnace was as follows:

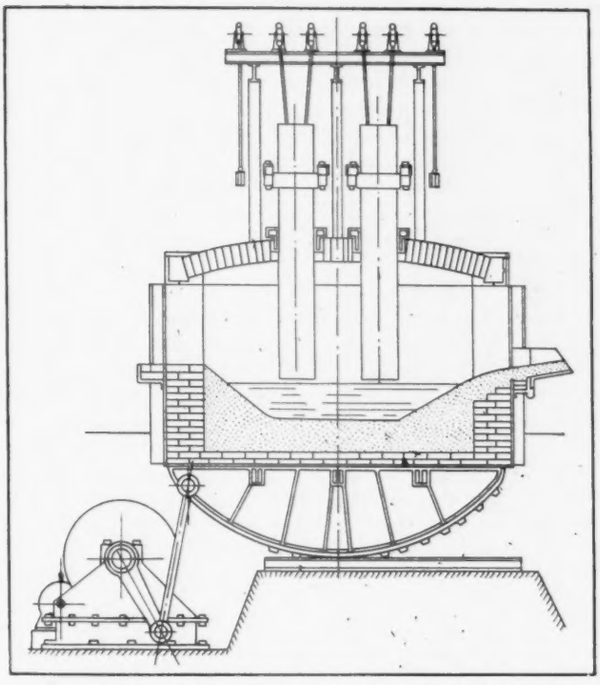


FIG. 2—ELEVATION OF CHARGING SIDE OF GRONWALL-DIXON ELECTRIC FURNACE

	Per cent.
Silicon	1.980
Phosphorus	0.313
Sulphur	0.044
Manganese	0.730
Combined carbon	0.630
Total carbon	3.280

From the metal a test bar of 1-inch square section was cast, the physical test being as follows: The bar was supported on knife edges, 12 inches apart, and sustained a load, applied in the middle, of 3,050 pounds before breaking, the deflection being 0.215-inch. The tensile strength was 27,570 pounds, with a Brinell hardness of 202. So far the work has been carried on only in an experimental way. The figures above as regards output and energy consumption are based on the making of high grade alloy steels to meet severe specifications. In making the ordinary run of steel castings it is believed these figures can be greatly reduced, more especially as no time need be lost in sampling and analyzing the metal during the actual operation. Generally speaking, a steel foundry requires a large number of small heats in quick succession. This is obtained by reducing the capacity of the furnace hearth itself and increasing the transformer capacity so that the charges of metal may be melted in a considerable shorter period of time than would be possible with conditions reversed.

Powdered Coal as a Fuel in Malleable Shops---III

By Joseph Harrington

HEAT is conveyed from a solid, incandescent body by radiation and convection. Gases do not emit radiant heat, but convey heat picked up from the incandescent fuel and transmit it to the object to be heated upon contact therewith. Just what proportion the radiant heat is as compared to the total amount developed is not exactly determinable, but the laws governing the intensity of radiation are definitely established. Those which concern this discusson, follow:

1.—The intensity of radiant heat varies inversely as the square of the distance between the source of heat and the receiving body.

2.—The intensity of radiant heat varies directly as the temperature of the glowing body.

In a gas producer it is quite obvious that no benefit is derived from the heat radiated from the glowing fuel. because the gas is burned at a distant point entirely detached from the gas producer. In the fire box of the malleable furnace there is only a very indirect utilization of this form of energy. A slight amount may be reflected from the furnace roof and impinge upon the metal being heated. I think, however, that this is a matter that could safely be entirely disregarded. We have therefore, in the standard construction, all of the heat generated in the solid fuel bed on the grate bars used up in two ways. First, by radiation to the furnace walls and roof, and back again to the fuel bed, causing a high temperature at these points, but without any corresponding benefit. Second, by heating the air of combustion for subsequent transmission to the metal on the hearth.

Radiant Energy Developed

That there is a very appreciable amount of radiant energy developed can be stated as a fact, and that there is a complete loss in the standard furnace can also just as safely be so stated.

In using pulverized coal these conditions are radically changed. The actual solid fuel is blown into the furnace above and around the metal and is ignited there and consumed in direct and intimate contact with it. There is an appreciable amount of solid fuel constantly in suspension in the furnace, and by virtue of the direct impingement of the powdered coal flame and its carbon upon the metal, there is the most direct and efficient application of the radiant heat to the metal. Under these conditions the bulk of the solid fuel reaches the incandescent state and gives off its radiant heat within a few inches of the iron, and there is no doubt about the consequent economy derivable therefrom.

Another interesting phase of the radiant heat is that this form of heat ray does not increase the sensible temperature of the intervening gaseous medium. All of the energy which the earth derives from the sun is of this form, and the sun's rays, which are nothing more than rays of radiant heat, pass through space of most intense cold. Upon striking the earth, however, the radiant heat is absorbed and appears as sensible temperature. It is obvious, therefore, that the radiated heat from the carbon particles in a malleable furnace gets directly

to the metal without raising the temperature of the furnace itself. By just that amount is the destructive effect on the brick work reduced, and by whatever amount is thus utilized, is the efficiency of the heating process increased.

The air introduced into the furnace from above, known ordinarily as top air, is placed there for two reasons. First, to supply the necessary oxygen for the complete burning of the hydro-carbon gases evolved in the first box; and second, to force the hot burning gases down to the metal bath. If it were not for some such deflecting agent, the gases from the fire-box would float along under the roof of the furnace and not touch the metal. The efficiency of the process of heat transfer by convection, therefore, would be greatly reduced, because in order to transfer heat by this method there must be an actual contact of the highly heated gases with the body to be heated. Therefore, it is imperative that the gases be forced down against the metal while at the same time it is supplied with the necessary oxygen for their final combustion.

It has been customary to apply this secondary air by means of from four to six nozzles, spaced across the top of the furnace and slanting downward towards the metal bath. This air usually is at several ounces pressure, and the velocity of the air jets is sufficient to carry along the bulk of the hot gas. It is almost obvious, however, that 2-inch jets of air spaced 15 or 20 inches apart, will not have a character other than that of jets. They will bore holes in the gas, and while, of course, the carrying effect of the jet extends for several inches in each direction, the effect is far from being continuous. The space between the jets is filled with furnace gas inadequately supplied with air, and in all probability it is this gas which finds its way along the furnace roof and eventually burns, if at all, in the rear of the furnace or in the flue leading to the stack.

Powdered Coal as a Gas

Considering now the radical difference between this method and the conditions which obtain with pulverized coal in suspension in a stream or jet of carrying air, one must conceive of the powdered coal having the character of gas in order to fully appreciate the controllability of the flame both as to direction and velocity and extent. The nozzles in this case are placed in such a manner that the fuel jet itself is directed downward toward the hearth. The velocity of the jet being controllable, the flame can be made practically any length desired. By using a high velocity jet it would be possible to cause the flame itself to directly strike the liquid iron and spread out in a continuous sheet over the surface of the metal, or to mingle intimately with the pile of iron on the hearth. On the other hand, it is equally possible to decrease the velocity of the jet to a point where it reaches the right part of the furnace close to the metal, and thereupon loses the velocity acquired at the nozzles, and becomes a floating mass of gas moving with relative slowness through the furnace. To hold the sheet of slowly moving, but very intensely heated gas near the surface of the metal, a relatively thin, continuous sheet of air can be introduced in the same place that the top air nozzles ordinarily are located. It is obvious that this secondary air, if introduced in a uniform sheet the entire width of the furnace, at least, at the moment of its introduction, will spread out into a very thin layer, having a maximum of exposed surface and a minimum of gaps through which unburned gases can pass. Those who have studied the action of furnace gases in passing through a boiler, will appreciate the fact that it is quite possible to prove the stratification of gases in a boiler setting. In this case the tubes of the boiler and the frequent turns made by the gases, have a decided mixing effect and yet a stream of excess air passing through a hole in the fire at one side of the furnace can be detected by means of gas analyses in the same relative location at the other end of the boiler.

In the malleable melting furnace, after the pile has begun to subside, there is little or no tendency for the gases to mix and the effect of the air curtain described, therefore, is to cause a stratification of the gases in the furnace. The hottest gases are held down in the furnace in direct contact with the metal bath. At the same time there is a certain protection to the roof of the furnace caused by the layer or stratum of air in immediate contact therewith. It undoubtedly will be conceded by melters that it would be desirable if the roof of a melting furnace could be lowered after the metal pile subsides and during the latter part of the heat until the clearance between the roof and the hearth should be cut in two. But it is necessary to have the roof a certain height in order to make it possible to charge the furnace, and this height, of course, has to be maintained at all times. However, the effect of lowering the furnace roof can largely be accomplished as previously indicated, and with a highly preheated air under control the incandescent, pulverized coal flame can be made to skim along the surface of the bath in direct physical contact therewith, and in the very best position to give up the maximum amount of heat thereto.

It is perhaps obvious from the foregoing that the beneficial result obtainable from the better contact of gas and metal and the utilization of the radiant heat, is a quicker melt with less burning out of the desirable elements of silicon, manganese and carbon.

With pulverized coal it is possible to get an incandescent front within a few minutes of the time of starting, even though the furnace be perfectly cold at that time. The long, slow, tedious process of building-up a furnace temperature by hand firing is avoided. It is under this condition of inefficient hand-operation that smoke is made, and the greatest amount of valuable combustible gas is lost through the stack. This condition continues until the entire furnace is hot enough to support combustion, but until such is the case, heavy volatile losses are suffered. This is in striking contrast to the conditions maintaining when using pulverized coal. In 10 or 15 minutes the front end of the furnace is dazzling white and this temperature is maintained consistantly until tapping is begun. It is inevitable that the iron should melt quicker under these conditions and just as inevitable that the losses of valuable ingredients should be reduced. Slag troubles do not occur because the ash liquifies and runs down on to the metal bath from which it is skimmed periodically with the rest of the slag. The conservation of the carbon, etc., has a directly favorable influence on the amount of high grade iron to be charged, and a definite saving, variously estimated from 2 to 5 per cent, is the result.

Foundry Cost Accounting

(*Continued on page* 490.)

reason of the fact, palpable to every foundryman, that the castings are frequently mixed up as they are broken out so that it is impractical to do this; therefore, the most equitable way to distribute this labor is pro rata weight of metal, but at any rate local conditions can largely govern this.

Counting and Weighing:—This should cover all labor expended upon the counting, weighing and testing of all kinds of castings. It is obvious that this labor is best distributed pro rata weight of metal.

Repairing:—This should cover all labor expended upon castings in the way of salvaging them, so that they will pass inspection, and should be charged to part number.

This classification practically covers all labor in the foundry that may be construed as productive.

Non-Productive Labor

The non-productive labor can be classified as the needs of each foundry may dictate. We will always have such items as supervision, clerks, sweepers and cleaners, etc., and a very good test of determining what constitutes non-productive labor may be

found in the following definition:

"Non-productive labor is:

(a) All labor that is in direct or indirect supervision to productive labor.

(b) All labor that is expended upon repairs and maintenance of the buildings, equipment and grounds.

(c) All time allowed to productive workers for overtime in excess of actual time worked."

As many sub-divisions of this can be created as will meet the needs of each individual foundry.

If, now, we begin with the metal at the spout and distribute the labor performed upon castings, as it progresses from one state to another along the lines laid out, and let each class carry its own burden, we find, that at each stage we will be able to tell exactly what the casting has cost up to such point. And that brings us to the burden.

Burden, as everyone knows, is composed of the non-productive labor, non-productive supplies or material, and the general overhead.

This may be computed monthly; or it may be computed yearly; or part of it may be computed monthly, such as non-productive labor and the non-productive material, and the general overhead may be computed yearly. Personally, the writer favors the latter method, because it has the tendency of recording conditions instantly, but there is no question but what the yearly computation of the general overhead, covering insurance, rent, taxes, etc., is the logical method for that part.

Regardless of how this is done, let the total of this be divided by the total amount of productive labor, which will give the percentage that the productive labor should bear as its burden, with the exception of the burden of the core room. This department uses so many ingredients and different kinds of material that are not used in any other part of the foundry, that it is not fair to the foundry to load it with the expense of this department, and, therefore, so far as the direct burden is concerned (which includes non-productive labor and non-productive material) whatever is consumed in the core room should be loaded on the core room by itself.

If the castings made in the foundry are now divided into classes, each class including all castings that have about an equal amount of molding and core labor, or (if it is desired to obtain a very minute and detailed cost) if all the castings in the foundry are segregated by their part numbers, we will, by this method, arrive at the extra cost per pound of the finished casting.

We would obtain the same result if we would compute all the productive labor, regardless of where it was spent, and load it with this burden, but it would not give us the cost of the casting at the spout, nor in the mold, nor anywhere else, except in its final state; and therefore, if there is an excessive amount of labor spent anywhere along this line, we would not be able to analyze it or find where the leaks are, and foundrymen would be working blindly just as much as if they had no cost system at all.

In the machine shop, it is possible to follow a certain piece of iron along its entire course, from its raw state to its finished condition. In the foundry, this is not possible, except perhaps, in the case of exceedingly large castings, but this method has proven efficacious in many instances and

(*Continued on page* 507.)

The Normal Fracture of Malleable Iron

By Enrique Touceda

FEW photographs of fractures of malleable iron show the appearance distinctly, the usual photographs simply show the fracture of a test lug that has been hammered off a casting, the fracture of a test piece, or of a casting that has been broken transversely. Such fractures are made complex by virtue of the fact that failure takes place due to the influence of both tension and compression stresses, these being of varying intensity depending upon their distance from the neutral axis. While failures in castings of any kind, in the majority of cases, are due to loads that produce bending, torsion or both, still I believe this subject can be more accurately approached by a study of fractures that have been produced through the sole action of a direct pull, as in making tension tests. A test lug, for instance, is generally broken in a very indifferent manner, and often the first few blows are delivered so squarely upon the point of the lug that compression is about the only stress produced. The idea seems

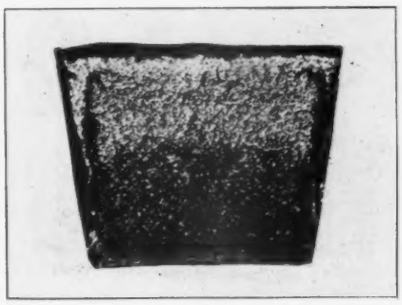


FIG. 1 — FRACTURE OF MALLEABLE IRON BROKEN TRANSVERSELY

to be to hit the lug squarely on end, curling it up more and more by repeated blows until fracture takes place. The direct blows tend to compress and flatten out those crystals on the tension side of the lug as well as on its compression side and slip planes are not only produced but ductility may be practically destroyed.

It is evident that if a crystal of pure iron is compressed and flattened out, its subsequent ability to elongate when pulled is greatly reduced. Consequently, when the lug is struck side blows to knock it off the casting, we will see numerous shiny particles on the tension side of the fracture, because, as already explained, the ductility of the crystals has been greatly lessened by the compression which they previously sustained and they will, when subjected to a pull, part through the slip bands instead of stretching. This leaves facets that will sparkle, so that the tension side of the fracture will have an abnormal appearance, be the material good, bad or indifferent, as compared with what the fracture of these respective grades would show if subjected to transverse or tensile stress only.

When malleable iron is broken transversely, the metal on one side of the neutral axis is of course in compression, and in any quality of malleable it will always appear silvery white at the extreme edge of the compression side, the whiteness being less in evidence as the neutral axis is approached, because, as stated, the compression stresses are of varying intensity, and the crystals farthest from the neutral axis are flattened much more than those nearer to it. Fractures that have been produced by transverse stress will always show

A paper read at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 16, 1916.

a silvery white area on the compression side, starting faintly to one side of the neutral axis and growing deeper as the edge is approached, as is plainly illustrated in Fig. 1.

From the foregoing, it is clear that if we desire to ascertain the appearance of the fracture of malleable iron it is desirable to see what its fracture looks like when the metal in the entire section has been subjected to the same treatment as would be the case in a tension test. As you are doubtless aware, the structural composition of malleable iron consists simply of two constituents, including about 98 per cent, by weight, of ductile iron practically free from carbon, and about 2 per cent of small rounded particles of graphitic carbon uniformly distributed throughout this mass of iron, except within the decarbonized border.

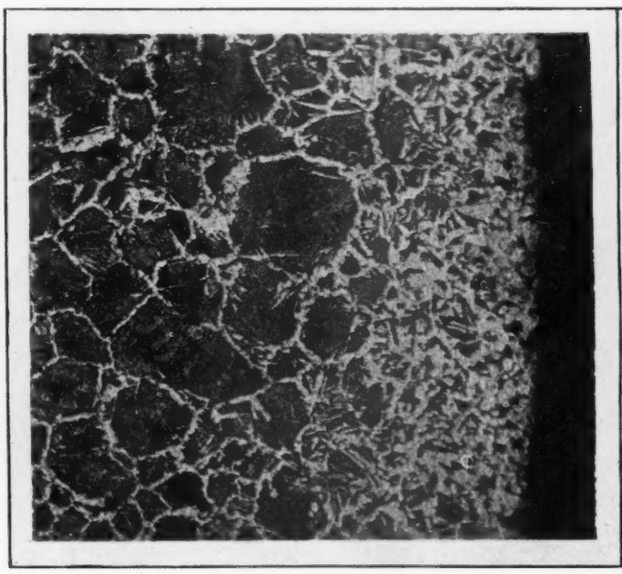


FIG. 2—SECTION OF A PIECE OF STEEL SHOWING DIFFERENCE BETWEEN SKIN AND CORE

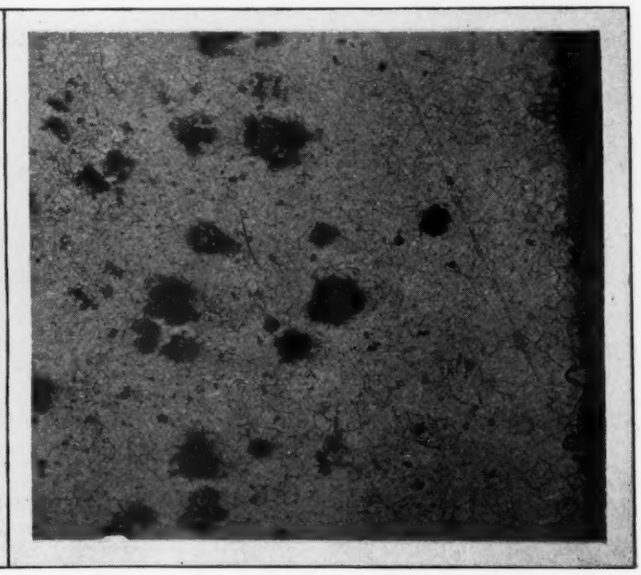


FIG. 3—STRUCTURE OF DECARBONIZED BORDER AND CORE OF ONE OF THE TEST BARS SHOWN IN FIG. 4

It is a well known fact that it is not possible to heat a steel casting, a steel billet, or a malleable iron casting in the oxidizing gases of a furnace without removing a great deal, if not all, of the carbon from the metal for a certain depth under its surface. In commercial practice this depth will vary anywhere from a 1/32-inch to a 1/16-inch. As steel contains no graphitic carbon the fracture of a broken piece will be uniform in appearance throughout, and the characteristics of the fracture can best be described by the accepted term "Steely". The microscope, however, will disclose the fact that there is very much less carbon in the nearly decarbonized ring of metal referred to, than in the core which it encircles. The reason, that when the fracture is examined by eye, the border is similar in appearance to the core in the case of steel is due solely to the fact that the appearance of the steel fracture does not depend upon carbon percentage, unless the amount of carbon between the steels that are being compared varies greatly. For instance, the fracture of a 0.10 per cent carbon steel would look about the same as one that contained 0.40 per cent carbon. A polished and etched section, however, when viewed under the microscope shows that a great difference exists between the two, which can be plainly seen by reference to Fig. 2, enlarged 60 diameters. This illustration shows the difference in structural composition between the skin and core of a piece of steel that was 5/8-inch thick.

Even in the case of the very best malleable iron the eye easily distinguishes the difference in appearance between the decarbonized border and the metal it surrounds, because the former is practically carbonless and looks steely, while the latter is dotted with numerous particles of graphitic carbon causing the metal to look dark. Consequently, due to contrast, the border is plainly visible.

In Fig. 3, which is enlarged 60 diameters can be seen both the structure of the decarbonized border and the core, as it is misleadingly called, of a section taken from one of the tensile test bars shown in Fig. 4. The skin, as you will note, is practically free from carbon, while the little particles of graphitic carbon can plainly be seen distributed with great uniformity throughout the iron of the core. You are aware that any commercial iron product containing but little combined carbon must of necessity be ductile, and as good malleable iron contains but little, if any, it must be ductile material.

If I have dwelt upon this matter somewhat at length it is because there appears to be an erroneous opinion, first, in connection with the characteristics of the border or skin of malleable iron, second, because of the common belief that a decarbonized border or skin is unique in malleable iron and not present in steel, owing to its invisibility in the fracture, third, because the skin must be taken into account in considering the fracture of malleable iron, and fourth, because this so-called skin can in the case of inferior malleable iron be of itself an explanation of its inferiority. Fig. 4 shows the fracture of three tensile test bars. The bars have been held in such a position that the fractures were perpendicular to the axis of the lens; while in Fig. 5 another view of these same fractures can be seen. In the latter illustration the plane of the fractures was held oblique to the axis of the lens.

These two views were taken for the purpose of illustrating the appearance of the fracture of good malleable iron when broken by direct tension and when held at different angles to the direction of the light.

When this material fails, due to a steady, direct pull, the crystalline grains of iron, when the elastic limit has been reached, start to elongate permanently. As the test

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—III

Letter	Name	Composition by percentage					
		Copper	Tin	Zinc	Lead, Maximum	Iron, Maximum	Miscellaneous
A	Admiralty	70 (min.)	1 (min.)	Remainder	0.075	0.06	
Be-r	Benedict nickel	84–86	.....	.....	.....	.....	Remainder nickel.
B-r	Sheet brass and piping	60–70	.....	Remainder	0.5	.....	
B-r	Commercial brass rod	60–63	.....	Remainder	3.0	.....	
Cu-r	Copper	99.5 (min.)	.....	.....	.....	.....	
D-r	Muntz metal	59–62	.....	Remainder	0.6	.....	
P-r	Phosphor bronze*	85–95	5–10	4 (max.)	0.2	0.06	Phosphorus, 0.15.
Mn-r	Manganese bronze*	57–60	0.5	37–40	.....	1.0	Managanese, 0.30.
Mo-r	Monel metal	Remainder	.....	.....	.....	3.5	Nickel, 60 (min.); aluminum, 0.5 (max.)
N-r	Rolled naval brass	59–63	0.5–1.5	Remainder	0.2	0.06	

* The figures given are approximate and are a guide as to the proportion of the elements except those for lead, aluminum, and iron, which are maximum limits.

White Metal

Composition: 3.7 per cent of best refined copper, 88.8 per cent Banca tin, 7.5 per cent of regulus of antimony. (Well fluxed with borax and rosin in mixing.)

Turbine Materials

Blading and binding strips may be made of the following compositions:

1.—Monel metal.
2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.
3.—Cupro-nickel: 79-81 per cent copper; remainder nickel; iron not to exceed 0.75 per cent.
4.—Composition: 53-56 per cent copper; 1.5 per cent nickel alloy; remainder zinc; lead not to exceed 0.5 per cent.
5.—Phosphor bronze.

Calking Strips

Composition: 62-63 per cent copper; remainder zinc; lead not to exceed 0.6 per cent.

Dummy and Gland Strips

1.—Naval rolled brass.
2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.

Thrust Rings

Composition: 82-84 per cent copper; 12.5-14.5 per cent tin; 2.5-4.5 per cent lead.

COMPOSITION OF MISCELLANEOUS ALLOYS

ALLOYS	Antimony	Bismuth	Copper	Gold	Iron	Lead	Nickel	Silver	Tin	Zinc	Cadmium
Brass, common yellow	....	....	61.6	....	....	2.9	....	....	0.2	35.3	....
Brass, to be rolled	....	....	32	....	....	....	....	....	1.5	10	....
Brass castings, common	....	....	20	....	....	....	....	....	2.5	1.25	....
Brass castings, hard	....	....	25	....	....	....	....	....	4.5	2	....
Brass propellers	....	....	8	....	....	....	....	....	1	0.5	....
Gun metal	....	....	8	....	....	....	....	....	1	....	....
Copper flanges	....	....	9	....	....	....	....	....	0.26	1	....
Muntz metal	....	....	6	....	....	....	....	....	....	4	....
Bronze statuary	....	....	91.4	....	....	1.37	....	....	1.7	5.53	....
German silver	....	....	2	....	6.5	....	7.9	....	....	6.3	....
Brittania metal	50	25	....	....	....	....	....	....	25	....	....
Chinese silver	....	....	65.1	....	12	....	13.0	2.58	....	19.3	....
Chinese white copper	....	....	20.2	....	....	....	15.8	....	1.3	12.7	....
Medals	....	....	100	....	....	....	....	....	....	8	....
Pattern letters	15	15	....	....	....	70	....	....	....	....	....
Pinchbeck	....	....	5	....	....	....	....	....	....	1	....
Babbitt metal	2	....	0.5	....	....	....	....	....	25	....	....
Bell metal	....	....	4	....	....	....	....	....	1	....	....
Chinese gongs	....	....	40.5	....	....	....	....	....	9.2	....	....
White metal, ordinary	28.4	....	3.7	....	....	....	....	....	14.2	3.7	....
White metal, hard	....	....	35	....	....	....	....	....	2.2	13	....
Metal to expand in cooling	16.7	8.3	....	....	....	75	....	....	....	....	....
Pewter	17	....	....	....	....	....	....	....	100	....	....
Spelter	....	....	1	....	....	....	....	....	....	1	....
Type metal	1	....	....	....	....	3–7	....	....	....	....	....
Solders—											
Newton's, melts at 212 deg. F	....	8	....	....	....	5	....	....	3	....	....
Rose's, melts at 201 deg. F	....	2	....	....	....	1	....	....	1	....	....
Very fusible, melts at 155 deg. F	50	....	....	....	....	25	....	....	12	....	13
Less fusible, melts at 199 deg. F	5	....	....	....	....	3	....	....	2	....	....
Tin solder, coarse, at 500 deg. F	....	....	....	....	....	3	....	....	1	....	....
Tin solder, ordinary, at 360 deg. F	....	....	....	....	....	1	....	....	2	....	....
Tin solder, melts at 225 deg. F	....	50.8	....	....	....	27.8	....	....	21.4	....	....
Brazing, hardest	....	....	3	....	....	....	....	....	....	1	....
Brazing, hard	....	....	1	....	....	....	....	....	....	1	....
Brazing, soft	....	....	4	....	....	....	....	....	1	3	....
Brazing, softest	1	....	....	....	....	....	....	....	2	....	....
Copper to copper	....	....	55	....	....	....	....	....	5	40	....
Copper to iron	....	....	80	....	....	....	....	....	4	16	....
Iron solder	....	....	2	....	....	....	....	....	....	1	....
Steel solder	....	....	3	....	....	....	....	19	....	1	....
Fine brass work	....	....	8	....	....	....	....	1	....	8	....
Pewter solder, ordinary	....	....	....	....	....	1	....	....	2	....	....
Pewter solder, soft	....	2	....	....	....	4	....	....	3	....	....
Lead solder	....	....	....	....	....	33.0	....	....	16	....	....
Aluminum solder, soft	45	....	....	....	....	....	....	....	25	30	....
Aluminum solder, hard*	....	....	....	....	....	....	....	....	....	75	....
Gold solder	....	....	1	24	....	....	....	2	....	....	....
Silver solder, hard	....	....	1	....	....	....	....	4	....	....	....
Silver solder, soft†	....	....	....	....	....	....	....	2	....	....	....

* 25 parts aluminum. † 1 part brass wire.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, DECEMBER, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

proceeds, they stretch further and become thinner, and just prior to fracture they become tapered down to a point.

The fracture then has what is known as a "tooth", because its surface is made up of an innumerable number of spines that have resulted from the elongation of the numerous grains in the metal. In Fig. 4, that part of the fracture encircled by the decarbonized ring appears to be of a dark gray color. This is due in part to the presence of small particles of graphitic carbon and in part to the shadows that are cast by the spines of the elongated grains. The skin, or border, looks white, due in part to the fact that no graphitic carbon is present and in part to light reflection. When the bar fails, the metal in the border being slightly more ductile, breaks last and at an angle, and consequently, when the light shines directly on the fracture of the core, it shines obliquely on the surface of the border. If, however, the bar is held obliquely to the direction of the light, as shown in Fig. 5, a very fine silky sheen will be seen that varies in shade from a silvery gray to darker shades of the same color, as the obliquity of the fracture to the light is decreased. Such will always be the appearance of the fracture of a tensile test bar of good malleable iron when the fracture is held in the various positions described.

FIG. 4—FRACTURE OF TENSILE TEST BARS HELD PERPENDICULAR TO AXIS OF LENS

If a bar is broken transversely, then the part that failed in tension should show, in a large measure, the characteristics covered by the foregoing description, while the part that was in compression would have the whitish looking area already referred to, and the more ductile the metal the greater will be the depth of this area.

Only a few years ago such fractures as are shown in Fig. 6 were considered typical of what the fracture of good malleable iron should be, and it is actually due to such fractures that malleable iron made in this country received the name "black heart". Such iron as this is defective, as the border instead of being decarbonized, contains considerable carbon in the combined form. As a matter of fact it is a steel, and consequently is more brittle than the core. When good malleable breaks in tension the core parts first, as must be the case if its ductility is slightly less than the metal in the skin. This fact alone is sufficient to prove that those who have claimed that the strength of malleable iron lies mostly in the skin are misled. In the case of material whose fracture is similar to that shown in Fig. 6, the skin breaks first as it is more brittle than the core.

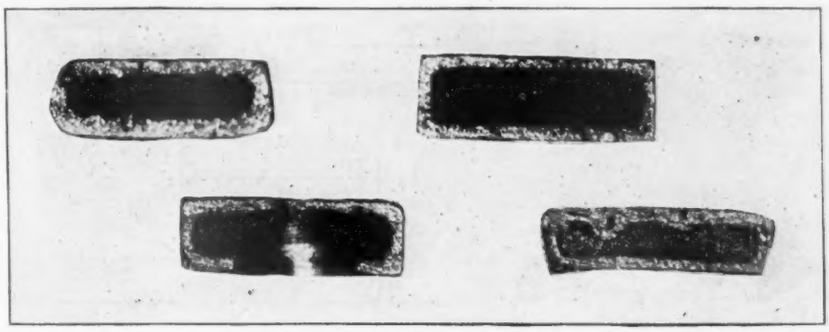


FIG. 6—FRACTURE OF BLACK-HEART MALLEABLE

FIG. 5—FRACTURE OF SAME BARS AS THOSE SHOWN IN FIG. 4 HELD OBLIQUE TO LENS

Balls for Grinding Wheels

By W. J. Keep

Question:—We are installing several mills at our smelter in which we will use about 3,000 pounds of 1½, 2 and 2¼-inch round balls daily. We intend to make the balls of semi-steel and would be pleased to have you furnish us with a good mixture. Also kindly advise what procedure to follow in making these balls and whether they should be made on a molding machine, cast in sand, or in an iron mold in which from 12 to 16 balls could be poured.

Answer:—The only thing to watch is the silicon and phosphorus. Keep the silicon low in order to make the balls hard and the phosphorus low so that the metal will set quickly and thus make the balls round. You probably could use an iron mold, but there is liable to be a shrink which will cause a flat spot. The addition of steel scrap will give you a good casting and may cheapen your mixture. Steel scrap itself does not make a hard casting. If you add spiegeleisen in the cupola you can produce a casting which will be very hard and will wear unusually well. Manganese added in this way will make the casting so tough and hard that it cannot be cut, yet it may still be gray. Brake-shoes and the stamps for stamp mills are made from a mixture of spiegel with common scrap.

Making Divisional Patterns for Cast Iron Columns

Patterns for Structural Columns Should Be Arranged so That as Many Pieces as Possible Are Interchangeable; Otherwise the Number of Patterns Will Be Excessive

By R Robertson

THE column is referred to at a very early period in the records of written history. In describing the qualifications of Hiram, the molder, it is recorded that he was "filled with wisdom, understanding and cunning" qualifications which we believe are still possessed by those following Hiram's trade. The treatment of the column forms a most important study in architecture and is dealt with under its three principal parts, namely, the base, shaft and capital. In classical architecture, columns are divided into five distinct types, namely, Doric, Ionic, Corinthian, Tuscan and Composite. The first three are of Greek origin; the other two were added by the Romans. It is not our intention in the present article to enter into the physical properties of metals further than to state that cast iron, owing to its high power of resistance under compression makes a particularly suitable material for work in the nature of columns. Cast iron also has the additional advantage of being made ornate in form, which in certain instances is an important factor. Owing to these and other considerations, the column is a casting which presents itself with great frequency in jobbing foundries. Column castings usually are made in flasks, consisting of cope and drag, and the patterns are made in halves, jointed at the parting line, to permit of the top half of the pattern to be lifted with the top part of the mold, thus entailing less work to the molder and insuring a better casting.

This molding process involves placing half of the pattern and the bottom part of the flask on a board, and turning it over after ramming.

In preparing the pattern for a column, the base, shaft and capital are dealt with separately, as it is easier for the molder to draw each part independent of the other. As the patterns are in separate pieces, the bottom board must be arranged in such a way that the patterns, when placed in position, will lie on the same straight line.

To insure this, the bottom board is provided with a slot, about ½-inch wide, extending the entire length, as shown in Fig. 1. To maintain its correct form, the slot is protected by a thin strip of wrought iron sunk to the level of the surface of the board and secured by countersunk headed screws. The patterns to be placed on the bottom board are prepared with two guides, one at each end, which fit into the slot. In this way the different parts of the pattern, when placed on the board, are kept in one straight line, Fig. 2.

With column work it is necessary for the foundryman to arrange his patterns in such a way, that so far as possible they may be interchangable, otherwise he will find the number of his patterns increasing tremendously. A considerable saving in this respect may be effected by adopting what is known as the *divisional* method of pattern arrangement as illustrated in Fig. 3.

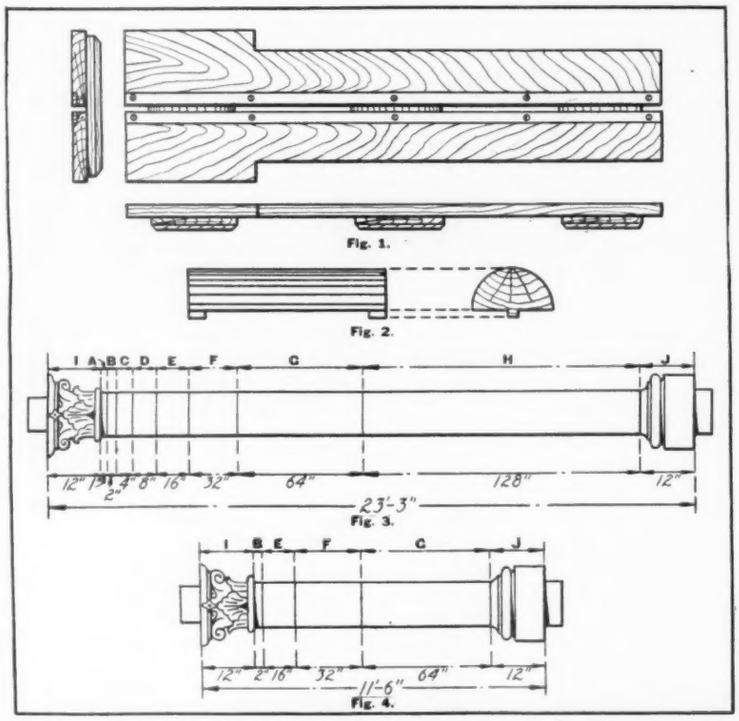


FIG. 1—SLOTTED BOTTOM BOARD ON WHICH THE PATTERNS ARE MOUNTED; FIG. 2—PATTERNS PROVIDED WITH GRINDERS; FIG. 3—DIVISIONAL METHOD OF PATTERN ARRANGEMENT; FIG. 4—A COLUMN PATTERN ARRANGED BY THE USE OF THE VARIOUS SECTIONS

It will be noted that the pattern for the shaft is made in eight pieces marked *A, B, C, D, E, F, G* and *H*. The capital is marked *I* and the base, *J*. Part *A* is 1 inch long; part *B* is 2 inches long; part *C* is 4 inches long; part *D* is 8 inches long; part *E* is 16 inches long; part *F* is 32 inches long; part *G* is 64 inches long; part *H* is 128 inches long, and parts *I* and *J* are each 12 inches long, but may be made any length. When these parts are placed on the slotted board, they total a length of 23 feet, 3 inches. With this *divisional* method of pattern arrangement, any length of pattern at intervals of 1 inch may be obtained, as illustrated in Table I. This can be continued until the height of column is only 2 feet and is made up of the base and capital parts only. Table I gives the first six alterations, but it will be noted that with these 10 pieces of paterns no less than 255 different lengths of pattern may be obtained. To determine the pieces to be withdrawn to give a certain length of pattern adopt the following rule: Find the difference between the length of pattern required and the total length when all pieces are placed, and remove the pieces which make a total equal to the difference.

For example, a pattern is required 11 feet, 6 inches long.

By the rule, 23 feet, 3 inches less 11 feet, 6 inches = 11 feet, 9 inches.

Therefore, pieces marked *H. D. C* and *A* must be withdrawn, because 10 feet, 8 inches, 8 inches, 4 inches and 1 inch make a total of 11 feet, 9 inches.

The pieces to be retained would be *I, B. E. F. G* and *J*, as shown in Fig. 4.

It will facilitate the progress of the

Table I.

Lengths of Patterns That May Be Obtained at Intervals of 1 Inch

	12 in.	1 in.	2 in.	4 in.	8 in.	16 in.	32 in.	64 in.	128 in.	12 in.	Length of column. ft. in.
With pieces.....	I	A	B	C	D	E	F	G	H	J	23 3
With pieces.....	I		B	C	D	E	F	G	H	J	23 2
With pieces.....	I	A		C	D	E	F	G	H	J	23 1
With pieces.....	I			C	D	E	F	G	H	J	23 0
With pieces.....	I	A	B		D	E	F	G	H	J	22 11
With pieces.....	I		B		D	E	F	G	H	J	22 10
With pieces.....	I	A			D	E	F	G	H	J	22 9

work if each piece of pattern is stamped with its reference letter and when a pattern order is issued to the foundry, it should refer to these letters in addition to showing the height of column. Table II gives the variations in a series of eight divisional patterns.

In Fig. 2 a wooden pattern is indicated. It hardly is necessary to state, that when there is a run of this work it is more economical to make the different pieces of patterns in iron, in which case they would be the shell type with the guides cast-in as webs.

There is still another point to be considered and that is with reference to the core. Unless some similar arrangement is adopted with the core a new loam board would be necessary for each alteration in the length of the column. To obviate this difficulty, the loam boards are made in lengths to correspond with the different pieces of pattern.

The pieces of loam boards are prepared with guide strips in the same manner as the patterns. These fit into a slot on the core bench and each piece is held in position by an iron bolt, as shown in Fig. 5. Each piece of loam board is marked by a letter corresponding to that part of the divisional pattern which is of the same length as the loam board. Wood patterns for columns, small in diameter, usually are made solid. For columns of large diameter the patterns are built-up in sections of four, six, eight or more parts, according to the size of the column and the thickness of the wood available.

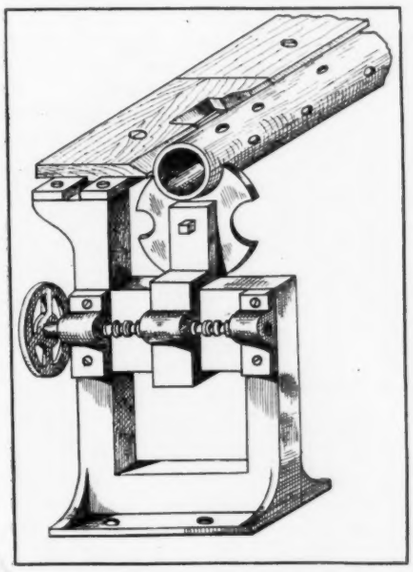
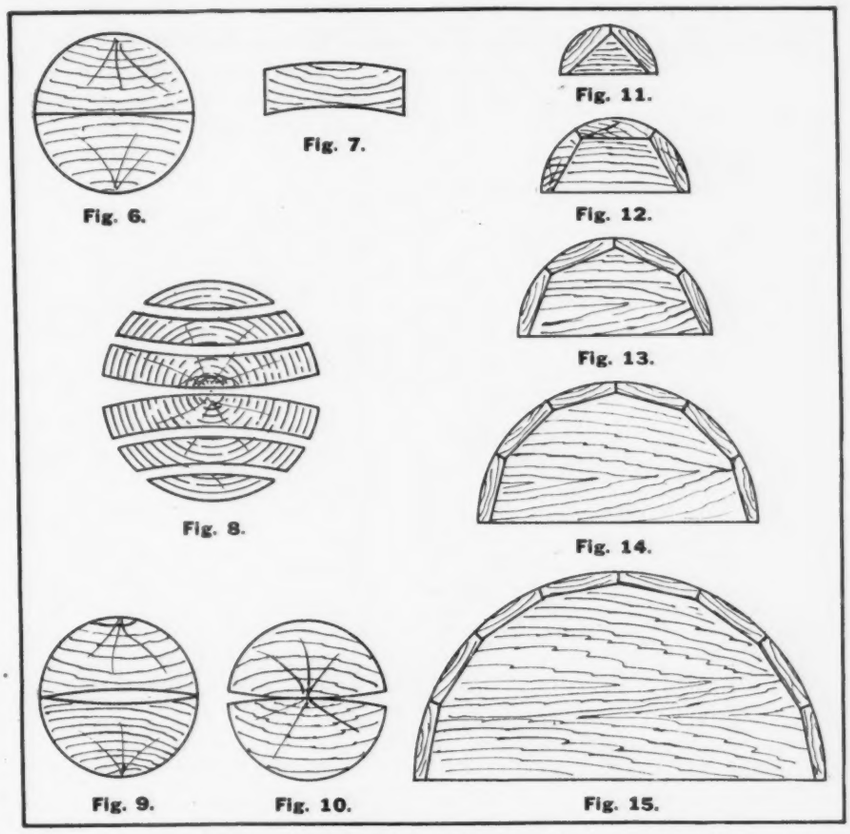


FIG. 5—LOAM BOARDS ARE FITTED WITH GUIDE STRIPS WHICH FIT INTO A SLOT ON THE CORE BENCH

Fig. 6 shows the section of a solid pattern. When a pattern is made in this form, it is important that the physical property of the wood be taken into consideration before the pattern is jointed. If this is not attended to defective patterns may be produced. Owing to its botanical nature, wood, when cut into logs, becomes round on the one face and hollow on the other, Fig. 7. Fig. 8 shows, in an exaggerated form, the action which takes place when wood is cut into sections.

It will be observed how important it is to patternmakers that they should be conversant with the law which regulates the bending of wood in seasoning, because in bringing two pieces of wood together, in one case the joints at the parting of the mold remain close, Fig. 9, and if incorrectly brought together they become open, as shown in Fig. 10.

Wood in seasoning becomes hollow on the side nearest the outside of the tree. It follows, therefore, that the two faces which grew nearest the outside should be at the parting line. The annular rings, which will be seen on the end of the wood are indicated on sections. For economical reasons, the patterns for the shafts of columns of large diameter are built-up in sections, the number of sections increasing with the diameter. This is illustrated in Figs. 11, 12, 13, 14 and 15.



FIGS. 6, 7, 8, 9 AND 10—ACTION WHICH TAKES PLACE WHEN WOOD IS CUT INTO SECTION; FIGS. 11, 12, 13, 14 AND 15—HOW SHAFTS FOR COLUMNS ARE BUILT-UP

Using wood cut to a thickness of 1½ inches and allowing ¼-inch all around for turning, the following diameters of shafts may be obtained from the different methods shown:

Shafts up to 6 inches in diameter, as shown in Fig. 11.

Shafts above 6 inches and up to 12 inches in diameter, Fig. 12.

Shafts above 12 inches and up to 24 inches in diameter, Fig. 13.

Shafts above 24 inches and up to 36 inches in diameter, Fig. 14.

Shafts above 36 inches and up to 48

inches in diameter, as shown in Fig. 15.

The sections are kept together by blocks about 36 inches apart. Where possible, there should be an odd number of these blocks in the shaft and every alternate one prepared with a pin in the one half and a socket in the other, thus insuring pins at each end of the shaft. For example, if the shaft is 15 feet long, there would be five blocks, three with pins, the other two being prepared with rapping plates.

The method for building this class of pattern is as follows: A level board is required a little longer than the shaft and a straight line drawn thereon at a distance from the edge of the board to allow the edges of the blocks to overlap; the center of the blocks are kept straight on the board, as shown in Fig. 16. These blocks are temporarily attached to the board and the top section screwed to the blocks, care being taken that the heads of the screws will not project beyond the finished diameter of the column. The side section then is fitted against the top part and is in turn screwed to the block. The screws then are withdrawn, the joint faced with glue or shellac and then screwed up. Good shellac is preferable to glue, as it is not affected when in contact with moisture and is a most effective adhesive. Its method of preparation is as follows: Powdered shellac is placed in an iron receptacle and sufficient methylated spirits are added to cover the powder. It is allowed to lie until the powdered shellac has dissolved. A light is then applied to the mixture and allowed to burn for a short time. When the flame is extinguished, a thick, sticky substance is left, which is ready for application.

When two sections are attached, the blocks can be detached from the board and the remaining section fixed in position. This completes the building of one-half of drum or shaft, and after the edges at the joint are planed straight, the remaining halves of the block are put in position and the other sections built-up. In turning the shaft in the lathe, it should be roughed down to near the required diameter and to the finished size for about 2 inches from each end. The shaft then should be removed from the lathe and an edge planed straight between the two ends, which are the finished sizes. The shaft is again placed in the lathe and a line drawn along the planed part with a colored pencil. The column now can be turned down and finished to this line, which can be observed as the shaft revolves without any further sizing. When turning wooden shafts, especially those of the smaller diameters, provision has to be made to prevent vibration at the center in order that they may be correctly tooled to the required diameter. Several types of anti-vibrating devices are adopted in this class of work, one of these being shown in Fig. 17. The inner ring which revolves with the shaft works into a bushed recess and is secured to the wooden shaft by screws. The outer part is stationary and rests on the frame of the lathe. The center of the ring coincides with the center of ends of the shaft. In small columns a similar difficulty occurs with regard to the sagging of the core barrel.

This sagging is prevented by attaching at intervals a small wrought iron

Table II.

Variations in Length in Eight Divisional Patterns Marked A, B, C, D, E, F, G, and H

Inches 1	2	4	8	16	32	64	128	Total l'gth in
A	B	C	D	E	F	G	H	in.
						G		64
A						G		65
	B					G		66
A	B					G		67
		C				G		68
A		C				G		69
	B	C				G		70
A	B	C				G		71
			D			G		72
A			D			G		73
	B		D			G		74
A	B		D			G		75
		C	D			G		76
A		C	D			G		77
	B	C	D			G		78
A	B	C	D			G		79
				E		G		80
A				E		G		81
	B			E		G		82
A	B			E		G		83
		C		E		G		84
A		C		E		G		85
	B	C		E		G		86
A	B	C		E		G		87
			D	E		G		88
A			D	E		G		89
	B		D	E		G		90
A	B		D	E		G		91
		C	D	E		G		92
A		C	D	E		G		93
	B	C	D	E		G		94
A	B	C	D	E		G		95
					F	G		96
A					F	G		97
	B				F	G		98
A	B				F	G		99
		C			F	G		100
A		C			F	G		101
	B	C			F	G		102
A	B	C			F	G		103
			D		F	G		104
A			D		F	G		105
	B		D		F	G		106
A	B		D		F	G		107
		C	D		F	G		108
A		C	D		F	G		109
	B	C	D		F	G		110
A	B	C	D		F	G		111
				E	F	G		112
A				E	F	G		113
	B			E	F	G		114
A	B			E	F	G		115
		C		E	F	G		116
A		C		E	F	G		117
	B	C		E	F	G		118
A	B	C		E	F	G		119
			D	E	F	G		120
A			D	E	F	G		121
	B		D	E	F	G		122
A	B		D	E	F	G		123
		C	D	E	F	G		124
A		C	D	E	F	G		125
	B	C	D	E	F	G		126
A	B	C	D	E	F	G		127

Inches 1	2	4	8	16	32	64	128	Total l'gth in
A	B	C	D	E	F	G	H	in.
							H	128
A							H	129
	B						H	130
A	B						H	131
		C					H	132
A		C					H	133
	B	C					H	134
A	B	C					H	135
			D				H	136
A			D				H	137
	B		D				H	138
A	B		D				H	139
		C	D				H	140
A		C	D				H	141
	B	C	D				H	142
A	B	C	D				H	143
				E			H	144
A				E			H	145
	B			E			H	146
A	B			E			H	147
		C		E			H	148
A		C		E			H	149
	B	C		E			H	150
A	B	C		E			H	151
			D	E			H	152
A			D	E			H	153
	B		D	E			H	154
A	B		D	E			H	155
		C	D	E			H	156
A		C	D	E			H	157
	B	C	D	E			H	158
A	B	C	D	E			H	159
					F		H	160
A					F		H	161
	B				F		H	162
A	B				F		H	163
		C			F		H	164
A		C			F		H	165
	B	C			F		H	166
A	B	C			F		H	167
			D		F		H	168
A			D		F		H	169
	B		D		F		H	170
A	B		D		F		H	171
		C	D		F		H	172
A		C	D		F		H	173
	B	C	D		F		H	174
A	B	C	D		F		H	175
				E	F		H	176
A				E	F		H	177
	B			E	F		H	178
A	B			E	F		H	179
		C		E	F		H	180
A		C		E	F		H	181
	B	C		E	F		H	182
A	B	C		E	F		H	183
			D	E	F		H	184
A			D	E	F		H	185
	B		D	E	F		H	186
A	B		D	E	F		H	187
		C	D	E	F		H	188
A		C	D	E	F		H	189
	B	C	D	E	F		H	190
A	B	C	D	E	F		H	191

Inches 1	2	4	8	16	32	64	128	Total l'gth in
A	B	C	D	E	F	G	H	in.
							G	H 192
A							G	H 193
	B						G	H 194
A	B						G	H 195
		C					G	H 196
A		C					G	H 197
	B	C					G	H 198
A	B	C					G	H 199
			D				G	H 200
A			D				G	H 201
	B		D				G	H 202
A	B		D				G	H 203
		C	D				G	H 204
A		C	D				G	H 205
	B	C	D				G	H 206
A	B	C	D				G	H 207
				E			G	H 208
A				E			G	H 209
	B			E			G	H 210
A	B			E			G	H 211
		C		E			G	H 212
A		C		E			G	H 213
	B	C		E			G	H 214
A	B	C		E			G	H 215
			D	E			G	H 216
A			D	E			G	H 217
	B		D	E			G	H 218
A	B		D	E			G	H 219
		C	D	E			G	H 220
A		C	D	E			G	H 221
	B	C	D	E			G	H 222
A	B	C	D	E			G	H 223
					F		G	H 224
A					F		G	H 225
	B				F		G	H 226
A	B				F		G	H 227
		C			F		G	H 228
A		C			F		G	H 229
	B	C			F		G	H 230
A	B	C			F		G	H 231
			D		F		G	H 232
A			D		F		G	H 233
	B		D		F		G	H 234
A	B		D		F		G	H 235
		C	D		F		G	H 236
A		C	D		F		G	H 237
	B	C	D		F		G	H 238
A	B	C	D		F		G	H 239
				E	F		G	H 240
A				E	F		G	H 241
	B			E	F		G	H 242
A	B			E	F		G	H 243
		C		E	F		G	H 244
A		C		E	F		G	H 245
	B	C		E	F		G	H 246
A	B	C		E	F		G	H 247
			D	E	F		G	H 248
A			D	E	F		G	H 249
	B		D	E	F		G	H 250
A	B		D	E	F		G	H 251
		C	D	E	F		G	H 252
A		C	D	E	F		G	H 253
	B	C	D	E	F		G	H 254
A	B	C	D	E	F		G	H 255

hook to the face of the loam board, on which the core barrel rests. By this means the center of the core barrel is kept in line with the cutting edge of the loam board.

The thickness of the metal in columns should be regulated by the weight that each column has to carry. When the thickness of metal is not specified, a common practice is to allow ⅛-inch in thickness to every inch in the diameter, in columns ranging from 3 inches to 8 inches in diameter. A column 6 inches in diameter, therefore, would be ¾-inch in thickness, columns 3 inches in diameter and under would be ⅜-inch thick and columns 8 inches and above, 1 inch in thickness.

The strength of a column in cast iron can be determined approximately by the following formula.

$$W = \frac{36S}{1 + \frac{L^2}{400\ D^2}}$$

W × 2,240 = Crushing weight in pounds.
W = Crushing weight in tons.
S = Sectional area in square inches of solid part of pillar.
L = Length in inches.
D = Outside diameter.

$$\text{Working load} = \frac{\text{crushing load}}{10}$$

The following example will show the application of the formula: Find the working load, in pounds, for a column 72 inches long, 3 inches outside diameter and a metal thickness of ½-inch.

$$S = \left[\frac{O}{D} + \frac{I}{D}\right] \times \left[\frac{O}{D} - \frac{I}{D}\right] \times 0.7854 = (3+2) \times (3-2) \times 0.7854 = 5 \times 1 \times 0.7854 = 3.927$$

$$36S = 3.927 \times 36 = 141.372$$

$$1 + \frac{L^2}{400D^2} = 1 + \frac{72^2}{400 \times 9} = 1 + \frac{5184}{3600} = 2.44$$

$$W = \frac{141.372}{2.44} = 57.93 \text{ tons}$$

$$\text{Working load in pounds} = \frac{57.93 \times 2240}{10}$$

Working load = 12,976.32 pounds.

Foundry Cost Accounting

(*Continued from page* 501.)

simply uses the old fashioned way of foundry labor without disturbing, to any great extent, the conditions as they exist.

It is extremely necessary, however, that the records upon which this system is based, come in accurately.

The cost department, at no time, is other than a bureau of record and it must depend upon what is furnished to give accurate information. It should have three cardinal virtues—simplicity, availability and accuracy. It must be as simple as possible, in order to render it as little expensive as possible, and to (by far the greater reason) to have its reports easily understood.

It must possess availability, so that its findings may be taken up and considered, when the matters it covers are still fresh in the mind of the management, and not long after, when everybody has forgotten about them.

And whatever it renders must be absolutely accurate or else it serves no purpose whatever and forfeits its right to exist. This may take extra help, but who is there who will not spend a reasonable amount of money in order to obtain information which will enable him to save hundreds of dollars?

The great objection, in the minds of men who have opposed correct cost accounting, is that it costs money, and while the writer is the last man to advocate the spending of $5 to save $1, he certainly maintains that the spending of $1 to save $5 is good business, and that is what the cost accounting department will do if intelligently administered, and last but not least, if the information furnished is used by the management.

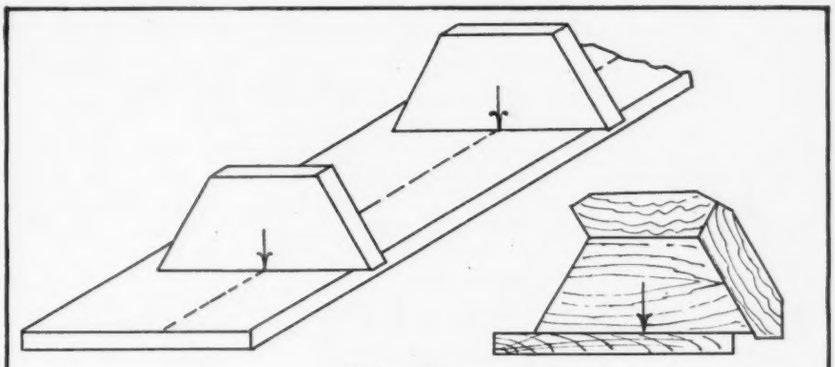


Fig. 16.

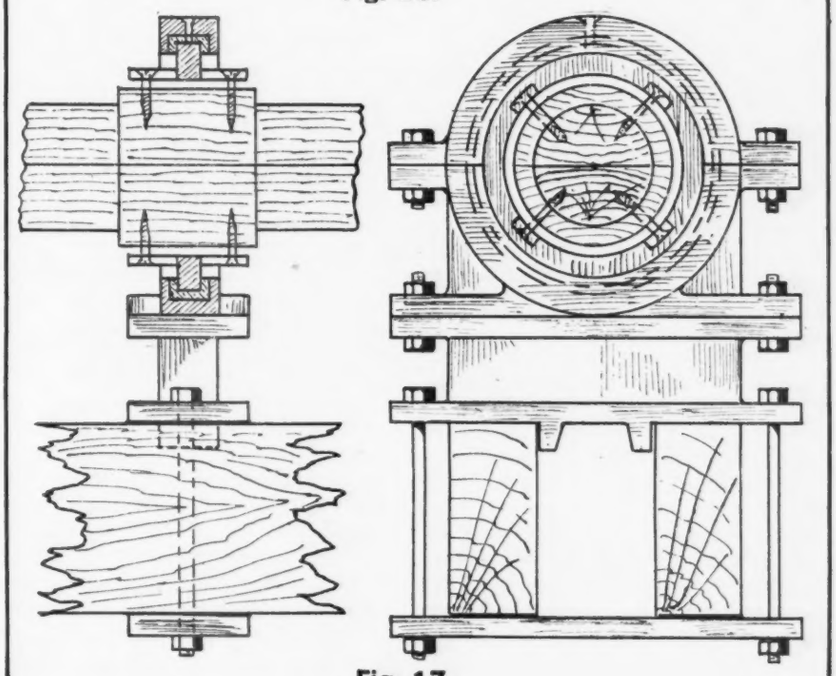


Fig. 17.

FIG. 16—THE FIRST OPERATION IN BUILDING-UP A SEGMENTAL COLUMN PATTERN; FIG. 17—ANTI-VIBRATING DEVICE FOR TURNING COLUMN PATTERNS OF SMALL DIAMETER, FOR ATTACHMENT TO THE LATHE

Care of Pneumatic Tools

An exceedingly interesting bulletin entitled "Lubrication of Pneumatic Tools" has been issued by the Chicago Pneumatic Tool Co., Chicago, which contains many valuable suggestions for the users of these devices. The recommendations, if followed out, will insure the efficient operation of air-driven tools and will greatly add to their period of usefulness.

The American Steel Foundries will erect an addition, 80 x 100 feet, to their plant at Franklin, Pa., which will be used for the molding department.

THE BRASS FOUNDRY

Chemistry in the Brass Foundry---VII

By E P Later

THE METHODS employed in estimating some of the more important metals in non-ferrous alloys now have been considered in detail and, it is hoped, with sufficient clearness to enable an inexperienced operator to obtain reasonably accurate results. Considered as separate determinations, that is, when only one metal is to be determined in an alloy, the preceding directions should prove satisfactory, but when a complete analysis of an alloy is required, or more than one metal is to be determined, it generally is customary to approach the problem in a slightly different manner. This is accomplished by combining some of the analyses in such a way that more than one determination can be kept going and one sample utilized, as far as possible, for the estimation of several of the constituents.

Properly done, this may be a saver of both time and labor, but a good deal depends, of course, on the composition of the metal under examination; sometimes it pays to weigh out two or three samples at the same time and to determine one or two metals only in each, rather than to determine all of them in one sample.

In this, the concluding article of this series, some of the various schemes employed in the analysis of metals or alloys will be presented. It may be stated that in most cases only an outline of the procedure can be given and for the details of the various determinations the operator should refer to the preceding articles of this series or some of the standard textbooks on quantitative analysis.

A sample of brass, for example, may contain a number of metals; some, of course, are present only in very small amounts, depending on the kind and quality of the material. If only one or two samples are to be run and it is desired to estimate the principal metals, say copper, zinc, tin and perhaps lead, several samples of one gram each should be weighed out. When an alloy contains a comparatively large amount of one or two metals, copper and zinc for instance, a 0.5-gram sample will suffice for the determination. These samples then may be taken into solution with dilute nitric acid and the tin estimated in one, copper in another, and so on, according to the methods which have been given previously. With a little practice it is not difficult to keep several determinations going at the same time, carrying each along until a stopping place is reached, that is, where the solution must be boiled or filtered or allowed to settle, then working with another one or two until everything is completed.

Procedure for Analysis

Ordinarily, however, when a more or less complete analysis is required about one gram should be weighed out and dissolved in 10 cubic centimeters of nitric acid diluted with about five cubic centimeters of water, covering with a watch glass and finally heating to boiling when the action becomes less vigorous. The solution then may be diluted with 50 or 60 cubic centimeters of boiling water and, after allowing it to settle, it is filtered through a double filter. The filter and precipitate should be dried and burned, as previously described, and the residue weighed as stannic oxide, containing a small amount of impurities. If desired, on the score of greater accuracy, this precipitate may be fused with a mixture of sulphur and sodium carbonate and the amount of the impurities determined.

To the filtrate from the tin, a few cubic centimeters of dilute sulphuric acid should be added and the whole evaporated until dense, white fumes are given off. The precipitated lead sulphate then may be filtered off, after the solution has been cooled and diluted somewhat, and the lead determined by any one of the methods given before.

Copper may be estimated in the filtrate from the lead, either volumetrically or electrolytically. In the former case the copper should be precipitated by passing hydrogen sulphide gas through the solution and the copper sulphide filtered off and washed with water containing hydrogen sulphide, to prevent oxidation. The precipitate then should be dissolved in a few cubic centimeters of nitric acid and the excess of this driven off by heating, after which ammonia should be added until the solution is slightly alkaline, followed by eight cubic centimeters of acetic acid and three grams of potassium iodine. The liberated iodine then may be titrated with standard sodium thiosulphate solution.

If it is desired to use the electrolytic method, the filtrate from the lead should be electrolyzed according to the directions given previously, using a weighed platinum dish or gauze as the cathode and a platinum wire spiral as anode.

When manganese is not present, time may be saved by determining lead and copper electrolytically at the same time. In this case it is not necessary, of course, to precipitate the lead as the sulphate, the solution containing the two metals being placed in a large platinum dish which has been carefully cleaned and weighed, and a weighed platinum crucible or spiral of heavy wire made to serve as anode; or, the ordinary gauze and spiral may be employed, both being cleaned and weighed previously. When a current is passed through the solution, the lead deposits on the spiral as oxide while the copper comes out on the dish or gauze. After deposition is complete both electrodes should be washed with water, then with alcohol, dried and weighed.

The filtrate from the copper should be heated to boiling, an excess of ammonia added and the solution boiled for several minutes, after which the precipitate may be filtered off. This consists of the aluminum and iron which were present in the alloy, with probably small amounts of manganese. If it is desired to determine these, the precipitate should be dissolved in a little hydrochloric acid, using no more than is necessary, then

sodium carbonate solution should be carefully added until a slight precipitate forms and does not redissolve. The solution should be allowed to stand for 15 or 20 minutes and acetic acid added, a few drops at a time, at intervals of several minutes until the precipitate dissolves, then five cubic centimeters of acetic acid may be added, followed by three grams of sodium acetate, the solution diluted to 250 cubic centimeters boiled and allowed to settle, finally filtering off the precipitate. The filtrate should be added to the filtrate from the iron and aluminum, in which manganese may be determined if desired.

Iron and Aluminum

The precipitate should be dissolved in a few cubic centimeters of dilute nitric acid, the solution should be diluted to about 150 cubic centimeters, brought to a boil and the iron and aluminum should be precipitated by a slight excess of ammonia. After boiling for several minutes, the precipitate may be filtered off and ignited, finally weighing as iron and aluminum oxides. The amount of iron present in the alloy may be determined on a fresh sample and, after calculating this to the oxide by multiplying by 1.429, subtracted from the weight of the combined oxides, thus finding the aluminum by difference, or, if a silver dish or crucible is available, the oxides may be fused in it with potassium hydroxide. The melt should be dissolved in water and the solution boiled, the residue filtered off and finally ignited and weighed as iron oxide, the weight of which multiplied by 0.7 will give the weight of metallic iron.

If it is not desired to determine the iron and aluminum the precipitate resulting from the addition of ammonia to the filtrate from the copper may be discarded. The filtrate should be treated with bromine water until a fairly deep color develops, then evaporated to about three-quarters of its former bulk, adding more bromine water if necessary. Any precipitate which forms will be manganese and if it is desired to determine this metal the precipitate may be filtered off, washed with hot water, then ignited and weighed as the oxide. The weight of this multiplied by 0.7202 will give the weight of metallic manganese. If the determination of the manganese is not required this precipitate may be discarded and, in any case, it would probably be advisable to use a fresh and much larger sample for the determination of this element, inasmuch as the amount present will ordinarily be very small.

The filtrate from the manganese should be boiled to expel any bromine, then after cooling the solution, about 50 cubic centimeters of a 10 per cent solution of hydrogen sodium ammonium phosphate should be added, the whole should be carefully neutralized with ammonia, using litmus paper for the indicator, and finally one cubic centimeter of acetic acid is added. After warming for an hour, the precipitate will settle and may be filtered off and the determination of the zinc finished as directed previously.

The analysis of ordinary bronzes is quite similar to the preceding. The tin may be determined in the same way as given for brass, or by one of the methods described previously for the estimation of this metal. To the filtrate from the tin, two or three cubic centimeters of strong sulphuric acid should be added and the solution evaporated until heavy, white fumes come off; then, after cooling, any lead sulphate which may have precipitated out may be removed by filtration and the lead determined.

The copper may be determined in the filtrate by any one of the methods which have been given.

Phosphor bronzes consist essentially of zinc, tin, copper, and phosphorus, but while the estimation of the three metals may be carried out without much trouble, the determination of the phosphorus presents greater difficulties and will not be considered here.

Phosphor Bronze Determination

The metals may be estimated by dissolving about one gram of the alloy in 10 cubic centimeters of dilute nitric acid, two parts acid to one part water, in a covered dish. The residue should be filtered off, washed with dilute nitric acid and warmed for a half an hour with a concentrated solution of sodium sulphide and then filtered off. The residue should be dissolved by warming with nitric acid and the solution is added to the main solution containing the rest of the copper and all of the zinc.

Hydrochloric acid should be added to the filtrate from the copper until it has a distinct acid reaction; then the solution should be allowed to stand in a warm place until the precipitate settles. The latter should be filtered off and washed with water containing ammonium acetate and a small amount of acetic acid, then dried and separated from the filter, which should be carefully burned in a weighed porcelain crucible. The ash should be moistened with nitric acid and the crucible heated, gently at first, to drive off the excess of acid, then the remainder of the precipitate may be added and the whole heated gently until the sulphur has been burned out and the tin changed from the sulphide to the oxide. The crucible then may be heated over the blast lamp, or at the full heat of the bunsen burner for a few minutes, cooled, a small lump of ammonium carbonate added and the whole heated again until the carbonate has been volatilized. This process should be repeated three or four times in order to drive off all of the sulphur or sulphuric acid, then the crucible may be allowed to cool and be weighed. As a precaution, it would be well to add ammonium carbonate and heat strongly once or twice more, then weigh again, to see if the weight changes. The residue is stannic oxide, tin oxide, and its weight multiplied by 0.788 will give the weight of metallic tin contained in it.

Determining Copper Content

The copper in the alloy may be determined in the main portion of the solution by neutralizing with ammonia, then adding about four cubic centimeters of nitric acid and one of sulphuric acid and electrolyzing in the usual manner.

Zinc may be determined in the filtrate from the copper by adding a few cubic centimeters of dilute sulphuric acid and heating until dense, white fumes come off freely, then employing from this point any of the methods previously given for the estimation of zinc.

An analysis often is required of solders or other alloys which consist essentially of lead and tin, or lead, tin and antimony; therefore, the method of procedure to be employed with these may be helpful.

About one gram of the alloy should be dissolved in dilute nitric acid—one part acid to one part water—in a covered dish; when the action is over, the solution should be diluted and the tin filtered off and ignited, as directed previously. This residue may be purified by fusion with a mixture of sulphur and sodium carbonate according to directions which have been given, and the amount of tin may be determined with sufficient accuracy for most purposes.

Lead may be estimated in the filtrate from the tin, and antimony, if this is present, by adding a few cubic centimeters of dilute sulphuric acid and heating until heavy, white fumes are given off, after which the solution may be cooled, diluted somewhat and the precipitated lead sulphate filtered off and the lead determined in the usual way. It is nearly as easy, however, and may save time, to use a fresh sample for the determination of the lead.

When antimony is also present it may be determined by boiling a fresh sample of the alloy for an hour with 80 cubic centimeters of dilute hydro-

chloric acid—concentrated acid diluted with its own volume of water—and one gram of potassium iodide, as given in a previous article.

It frequently becomes necessary to make a partial or complete analysis of babbitt metal, strictly, antimony, copper and tin, although cheaper varieties may contain antimony, copper, lead and tin, or of other alloys of analogous composition. Lead and copper may be determined by dissolving one gram of the alloy in a mixture of four cubic centimeters of hydrochloric acid and six of nitric, in a covered dish. An addition of a few crystals of potassium chlorate and gentle heating will hasten the action. When this appears to be complete, a small amount of tartaric acid should be added and the solution diluted with 30 or 40 cubic centimeters of water. It then should be made slightly alkaline with sodium hydroxide solution, followed by the addition of 20 cubic centimeters of a saturated solution of sodium sulphide, after which it may be kept hot, with frequent stirring, for about 30 minutes. After the precipitate has settled it should be filtered off and washed with water containing about 2 per cent of sodium sulphide.

The residue on the filter, consisting of the sulphides of lead and copper, should be dissolved in a few cubic centimeters of nitric acid, then 8 or 10 cubic centimeters of sulphuric acid should be added and the solution evaporated until heavy, white fumes are given off. After cooling and diluting somewhat, the precipitated lead sulphate may be filtered off and the lead determined as usual.

How Copper is Estimated

Copper may be estimated in the filtrate from the lead by boiling the solution with a piece of sheet aluminum to precipitate the copper, adding a few cubic centimeters of hydrogen sulphide water to precipitate any copper which may have remained in solution and finally filtering and dissolving the copper in nitric acid, according to directions which have been given previously. The copper is finally estimated by titration with standard sodium thiosulphate.

The antimony in the alloy may be determined by heating carefully over a flame one gram of the latter in a flask with seven grams of potassium acid sulphate, one gram of tartaric acid and 10 cubic centimeters of sulphuric acid, shaking with a rotary motion until all separated carbon and sulphur have been expelled. The flask should be allowed to cool on its side, otherwise, as the mass solidifies, it may break the flask. About 50 cubic centimeters of water and 10 cubic centimeters of hydrochloric acid should be added and the whole boiled for a few minutes, after which 10 cubic centimeters of hydrochloric acid should be added and the solution cooled by allowing cold water from the tap to run over the outside of the flask. After dilution to 200 cubic centimeters with cold water the solution may be titrated with standard potassium permanganate solution, as described before.

Tin may be determined in the same solution in which the antimony was estimated, by titration with standard iodine solution, but as this involves considerable manipulation in the way of passing carbon dioxide through the solution, it is probably advisable in the present instance to use a fresh sample. This should be fused in an iron crucible with stick sodium hydroxide; directions for all of the operations involved, including the final titration with standard iodine solution, were given previously.

Nickel Alloys

A few alloys containing considerable quantities of nickel, such as German silver and certain others, are widely used for some purposes, therefore, an outline of the methods employed in analyzing these may be of interest.

German silver, which may be taken as an example of this class of alloys, consists essentially of copper, zinc and nickel, all of which may be present in rather widely varying amounts. The copper may be determined directly by dissolving one-half gram of alloy in nitric acid, a few drops of hydrochloric acid may be added to hasten the action, and the excess of free acid boiled off after the solution of the metal is complete. Forty or 50 cubic centimeters of water then should be added, followed by a solution of sodium carbonate until the rest of the acid is neutralized and a blue precipitate of basic copper carbonate is obtained. This should be dissolved in a slight excess of acetic acid, eight cubic centimeters more added, and the solution boiled for a few minutes, to expel carbon dioxide, then cooled by allowing cold water from the tap to run over the outside of the flask. If much iron is present it will appear as a red scum or precipitate and should be filtered off before proceeding with the rest of the determination. About two grams of potassium iodide now should be added to the solution, either dissolved in water or as the solid salt, after which the mixture should be shaken and may then be titrated with standard sodium thiosulphate solution, as described under the estimation of copper. Lead may be determined by dissolving from one-half to one gram of the alloy in 5 or 10 cubic centimeters of nitric acid in a covered dish, washing down the cover and sides with a few cubic centimeters of water when the action is over, then adding four or five cubic centimeters of sulphuric acid and evaporating until heavy, white fumes are given off. After cooling and diluting, the precipitated lead sulphate may be filtered off and the lead determined in the usual way.

Estimation of Nickel

The estimation of the nickel presents no particular difficulties and may be accomplished by dissolving one-half gram of alloy in about 10 cubic centimeters of dilute nitric acid, strong acid diluted with its own volume of water. If there is any cloudiness, due to tin, this solution, when the action is over, should be allowed to cool and then be filtered, after which it should be diluted to 350 or 400 cubic centimeters with water and a one-half gram of tartaric acid added, followed by ammonia to distinct excess. The solution then should be heated somewhat short of boiling and about 50 cubic centimeters of an alcoholic solution of an organic compound known as dimethylglyoxime should be added.

The nickel comes down as a bulky, red precipitate and the solution should be allowed to stand in a warm place for 15 or 20 minutes, stirring now and then, after which it may be filtered off and washed with water containing a small quantity of ammonium nitrate.

This precipitate probably will contain a small amount of copper; therefore, for the sake of greater accuracy, the precipitate may be dissolved on the filter by pouring over it warm, dilute nitric acid, strong acid diluted with about four times its own volume of water. The solution should be allowed to run into a large beaker and then may be diluted and the nickel precipitated again as before. This time the precipitate should be filtered onto a weighed Gooch crucible, washed with hot water containing ammonium nitrate and finally dried at 212-220 degrees Fahr. and weighed. The weight of the precipitate multiplied by 0.20325 will give the weight of metallic nickel.

The dimethylglyoxime solution is prepared by dissolving enough of the solid material in ethyl, grain alcohol, to make a 1 per cent solution.

The Hyde Windlass Co., Bath, Me., recently cast some exceedingly large propellers. About a year ago, a 4-blade propeller, 19 feet 6 inches in diameter was turned out for the steamship CHIPANA, owned by W. R. Grace & Co.

This propeller was cast of manganese bronze and the casting weighed 26,000 pounds in the rough and 24,500 pounds after being finished. One of the new propellers that has just been completed is also of manganese bronze. It is 18 feet in diameter, and will drive a 12,000-ton vessel owned by the Isthmian Steamship Co. This casting weighed 20,000 pounds in the rough and approximately 26,000 pounds of metal were melted in order to pour it.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Mixture for Carburetors

In the manufacture of carburetors we are using some red brass scrap containing a large percentage of copper. The price of copper is getting so high that we are anxious to reduce the cost of our mixture, but our efforts in this direction have been extremely unsuccessful owing to the fact that the castings made from the cheaper mixture are invariably porous and cannot be used in the float chamber where a tight valve seat is necessary. Can you suggest a fairly cheap mixture and method of melting which would avoid porosity?

All red brass castings contain a large percentage of copper and it is impossible to make them without this constituent regardless of its cost. The following alloy is cheap and will cast sound when carefully melted: Copper, 87 per cent; zinc, 8 per cent; tin, 2 per cent and lead, 3 per cent.

Poling Copper

Kindly explain what is meant by poling copper.

Copper is *poled* by forcing green pine poles into the bath, at the same time covering the surface with charcoal. About 28 poles, 8 inches in diameter at the butt and 4 inches at the top and 35 bushels of charcoal are required per charge of 50 tons of copper. The poling is necessary to remove the excess oxygen introduced as compressed air for the purpose of slagging out the impurities. Commercial copper always contains a considerable amount of copper suboxide which shows in a microphotograph as curved dark bands of copper oxide eutectic between and within the crystals. The brass founder removes this oxide as much as possible by the aid of deoxidizers, such as phosphorus. In making copper castings the best deoxidizers to use are those that form a tough, tenacious film on the surface of the molten copper, through which gases cannot penetrate to be absorbed. Powerful deoxidizers like calcium and zirconium remove the oxygen and produce *overpoled* copper, that is, copper that cannot retain the other gases, such as hydrogen, etc., that have been absorbed. Such copper produces porous castings and their overpoled condition is indicated by the swelling and spewing of the heads and risers. When oxygen is present in proper amounts, these gases are soluble and the castings apparently are sound. The idea in poling is not to remove all the oxygen, but enough of it to bring the copper to *tough pitch* at which point it appears sound with a fine, silky fracture.

Anti-Friction Alloy Melting Difficulties

We are making an anti-friction metal consisting of lead, 78 per cent; antimony, 17 per cent; tin, 5 per cent and bismuth, 0.5 per cent. The results, however, vary considerably, as the metal seems to segregate and the fractures differ widely. The lead is melted in an iron pot, while the antimony is melted in the crucible and is poured into the lead, after which the tin and bismuth are added. An effort is made to maintain the metal at a low temperature while pouring, the molten mixture being dipped out of the pot with a hand ladle and poured into a water-cooled mold. During the pouring process we constantly stir the metal in the pot to prevent the lead from settling. We would like to have you make some suggestions for preventing the segregation of the lead, and also let us know whether our course of procedure is correct?

Your method of making this alloy can be improved considerably. It is not advisable to melt antimony alone in a crucible, as this element is volatile and, therefore, the percentage of loss in melting is high. It is preferable to melt a portion of the lead, constituting the mixture, in a crucible, and when at a red heat, to add the antimony gradually and as rapidly as it is dissolved by the lead. The molten, lead-antimony alloy then is poured into the balance of the molten lead in the kettle. The tin may be added last. The addition of ¼ per cent of 5 per cent phosphor-tin in place of an equal amount of tin will improve this alloy.

No. 12 Aluminum

Will you kindly furnish us with the formula for No. 12 aluminum alloy? We also would be pleased to have you advise whether any special class of sand is used in facing molds for aluminum match-plates.

The No. 12 aluminum alloy contains about 90 per cent aluminum and 10 per cent copper. This is believed to give better results for match-plate work than a harder mixture. In melting, watch the metal to prevent it from getting too hot. It should not be allowed to go past the silver heat, as unsatisfactory results are obtained if it is necessary to wait for the metal to cool before pouring. The facing sand for match-plate molds should not be any finer than a coarse stove plate sand and should be worked as dry as possible. The drag must be rammed as lightly as possible and it might be a good idea to dry the mold with a torch, as this will permit the use of much cooler metal and will give better results than if the mold is left green.

Result of Overheating Magnalium Metal

We are casting throttles for carbureters, using magnalium metal, but black spots develop when they are being machined. The metal is poured at a temperature of about 1300 degrees Fahr., and our mixture consists of 75 per cent new metal and 25 per cent old metal. Also, we are making aluminum castings, ¼ inch thick, which must be malleable and we would like to know whether there is any flux or alloy that would render magnalium metal malleable in order that it may be employed in the aluminum mixture.

The black spots are caused by the burning of the metal during the melting operation. The remedy is to keep the alloy at as low a temperature as possible, consistent with the required fluidity. Magnalium metal cannot be rendered malleable by the use of any flux. In this case it will be necessary to employ pure aluminum to obtain satisfactory malleable castings.

Problems in Gating Non-Ferrous Metal Castings

A Discussion of the Principles of Gating—Practical Suggestions for Selecting and Preparing Gates for Various Types of Non-Ferrous Castings

By Russell R Clarke

GOOD gates are instruments of control and media of transmission. This dual consideration is vital to gating results. By trend of lead, gates admit of a threefold classification, those leading to, those leading from and those coursing independent of the mold. Briefly they might be termed, gates of ingress, gates of egress and gates of independent lead. Exercising widely different functions, each type of gate thus classified must be studied and constructed accordingly.

Terms Applied to Gates

The term *gate,* as commonly used, is broad and general, indicating part, parcel and whole of these instrumental media. Practice is common to designate all parts compositely, a gate, and just as prevalent to refer to each part separately as such. For distinguishing purposes, individual terms such as *sprue, head, riser,* etc., frequently are applied, though the tendency is neither universal in scope nor uniform in term selection. Therefore, it is apparent that a well defined and universally accepted nomenclature of gates has been one of the overlooked items of scientific effort along non-ferrous foundry lines. To avoid present confusion, this discussion will adhere to the general term and use qualifying words to designate the particular gate or part of gate referred to. By such a method the following gates are briefly defined:

Pouring Gate.—Vertical ingress gate descending into the mold to the first abrupt change of direction and including a funnel-shaped top.

Pressure Gate.—Section of pouring gate above the highest point of the metal that is in the mold.

Drop Gate.—Vertical ingress gate used to *step* metal downward.

Button Gate.—Bowl-shaped basin underlying vertical gate to protect sand against the impact of the falling metal—a shock absorber.

Connecting Gate.—Horizontal gate joining the bottom of one vertical gate to the top of another.

Delivery Gate.—Mold attaching ingress gate.

Runner Gate.—Main intermediate between vertical and delivery gates.

Riser Gate.—Vertical egress gate, functioned to pass off surface metal dross and relieve the mold of sudden applications of force generated by the pressure gate and intensified by momentum of metal.

Skim Gate.—Either egress or gate of independent lead, mechanically constructed and positioned to trap dirt and dross and exempt mold metal from these objectionable materials.

Feed Gate.—Ingress gate, furnishing some part of the mold a higher temperature or greater bulk of metal than that reaching it through regular channels.

Horn Gate.—Gate resembling a horn. A sand hole delivery gate leading to some advantageous point in the mold not otherwise accessible.

U-Gate.—Modified form of horn gate realized through the use of dry sand cores and sub-surface in position.

Drop-Pouring Gate.—Method of getting metal into a mold with maximum speed and cleanliness. The plan of enlarging gate head cavity to hold all metal required to fill mold and gates, fitting a stopper core in the bottom of the cavity, filling cavity with metal and suddenly lifting the core.

Bottom Gate.—Delivery gate attaching at or near the bottom of the mold.

Pop Gate.—Vertical gate attaching direct to the casting. Mainly illogical in non-ferrous practice.

Flow-Off Gate.—Egress gate permitting excess metal to course through a mold or some part of a mold for some specific purpose.

Overflow Gate.—One taking care of excess metal furnished by a flow-off gate that terminates in the atmosphere.

Influence of Gates

Representative of non-ferrous practice in general and conservatively responsive to their designating terms as noted, the foregoing gates will be thus referred to in this discussion, their implied sense, as briefly delineated, attaching.

It is a fact that a non-ferrous gate exercises a tremendous influence over its casting status, independent of its mere capacity to transmit metal. Responsible to principle, that influence applies under all conditions of demand and is wholly independent of class or type of work. A gate can be so constructed as to menace any casting it will run. There is scarcely a class of non-ferrous work, light, medium or heavy, in foundry practice today that cannot be gated to the scrap pile. Nor does the proposition lack its practical and every-day foundry demonstration. Gate a 1½ x 12-inch round brass pin in the middle (longitudinally) and the highly probable result is

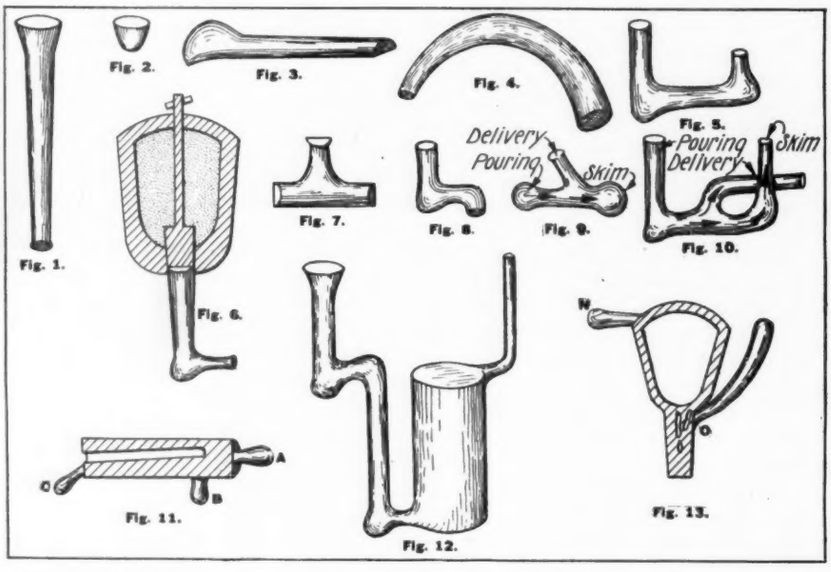


FIG. 1—POURING GATE. FIG. 2—BUTTON GATE. FIG. 3—RUNNER GATE. FIG. 4—HORN GATE. FIG. 5—U-GATE. FIG. 6—DROP POURING GATE. FIG. 7—HORIZONTAL DELIVERY GATE. FIG. 8—CONNECTING GATE. FIG. 9—SKIM GATE. FIG. 10—SKIM GATE MADE BY A CORE. FIG. 11—*A* BURNS THE CORE END; *B* DISPLACES AND BURNS; *C* STRIKES AT AN ANGLE AND AT POINT OF MAXIMUM CORE SUPPORT. FIG. 12—A 6 x 14-INCH BRASS PIN, GATED AND POURED FROM THE BOTTOM. FIG. 13—*N* SUPERINDUCES A DRAW IN THE HEAVY LOWER SECTION WHICH THE HORN GATE AT *O* OVERCOMES

A paper presented at the twenty-first annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11-15, 1916.

a draw in the casting; transfer the same gate to the end and the chances favor a good casting. Gates too high, too low, too far, too close, too soft, too hard, too large, too small; gates of illogical shape, volume, relation, placement and all, contribute more or less seriously to the defective casting evil in most all brass foundries of the day. From an experience covering ten years' inspection and examination into sources of casting defects, the author found at least 30 per cent of those sources identifying in some way or other within the gate.

A signally impressive example occurred when a foundry took an order for a large number of valve bodies under specifications on physical property covering a high pressure test. The alloy 88-10-2, manufactured from high-grade component elements, was decided on. The patterns were made and plate-mounted for machine molding. The castings failed utterly under the test. Every related detail in practice was gone over thoroughly and corrective measures instituted in all except the gating, with no substantial improvement in the finished casting. Finally, it was decided to alter the method of gating. The change had to do chiefly with delivery gate placement, and necessitated the remounting of the plate. Castings which were made after this change showed conclusively that previous difficulties were the direct result of poor gating. A further item of experience might challenge interest. The steam or forcing nozzle of a locomotive injector is a chunky, solid casting, weighing about three pounds and resembling a short section of tapering pin brass with a heavy knob on the heavy end, the heavy knob admitting a hexagon-shaped boss on the knob's extreme end. A mounted plate with gates attaching to the hexagon end produced castings with gate pin holes terminating in spacious cavities in the metal vitals of the knob. A smaller gate attached to the smaller end of the casting eliminated the difficulty and yielded perfectly clean and solid castings. It was all a matter of gating.

How, Where and Why to Gate

How and where to gate and why, are all significant items to the brass foundry. A gate is the connecting link between metal in the atmosphere and metal in a mold, between high temperature metal as a liquid and metal in its congealing and plastic state. It is at once apparent that the supreme function of a gate does not discharge with the delivery of its metal to the mold, and if properly designed and judiciously placed, it is not a hap-hazard affair, but rather a scientific creation calling forth the most critical thought and skill of the craftsman. For in the finals of knowledge applied, it is the gate—not the furnace, nor the crucible, nor even the cavity of pattern impression—that is given us to adjust those decreed differences attending metal as it passes from its liquid to its solid state.

The principles of good gating practice derive their origin from related natural principles whose province they invade. These natural principles are those of hydrostatics, of expansion and contraction, of radiation and of gravity as affecting falling bodies. In the interest of more practical discussion, we shall examine each only insofar as it is practically applicable.

Hydrostatics observe three primary principles: Common level, pressure transmission and incompressibility. Briefly, the applied sense is that liquid

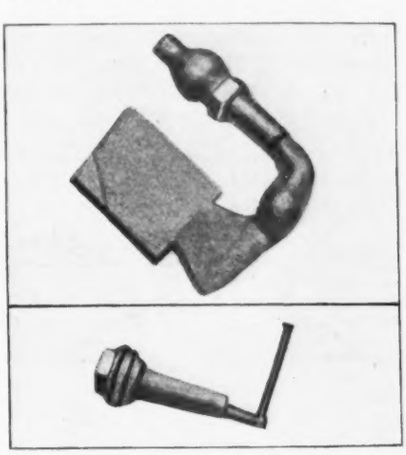


FIG. 14—EFFICIENCY OF DROP POURING—A THIN DISC AND A HEAVY BODY RUN TOGETHER, PERFECT CASTINGS RESULTING. FIG. 15—THE LEAD PENCIL IS AS LOGICAL AS THE SAW LOG—THIS CASTING IS PERFECTLY SOLID

metal of its own volition seeks common level in gate and mold, transmits free and undiminished its own weight derived pressure and practically declines to compress under that, or any other pressure applied. By incompressibility, the metal in the mold is guaranteed full gate pressure. Calculation on that pressure, therefore, is an item of particularity. Too little pressure will result in casting shrinkage, too great a pressure will superinduce mold swelling. Were liquids compressible, they would admit greater compactness, staying expansibility by pressure controled, which would tend to neutralize contraction and make the gating of a casting a mere matter of calculating the pressure required to thus compress. A paradoxical feature of hydrostatics is that liquid columns of equal height generate the same pressure utterly independent of their volumes. Contraction and expansion are all but irresistible forces; they vary with volume, operate with different degrees of intensity on different elements and are most dangerous to casting status at or near the freezing point of the metal. Mainly, non-ferrous metals seldom localize contraction's effect executed on them in their solid state. Gravity has to do with velocity and momentum of falling metal, both of which increase with time of descent. In practice, it is concerned with drop-gate partition and the logical construction and placement of button gates. Radiation is interested in either the simultaneous solidifying of gate vicinity in the casting and the gate, or the precedence of the former, the latter being preferred. It varies with volume and radiating surface.

Ignorance of Gating Principles

We shall not, we hope, be judged guilty of a sweeping accusation against average foundry intelligence when we conservatively estimate a great many molders sadly lacking in at least recognition and application of these basic principles. Nor do we presume to underrate the capacity for intelligence of those, who in actual ignorance of them, violate them, those who by the paradox of a thing narrow to the fallacy of a thing. Foundry apprenticeship and instruction have never been any too strong in the enunciation of basic principle. It has been a rather mechanical piece of business, a business more of teaching a thing than the why of a thing. It expects a man to follow a practice by merely observing a practice, to either dig up a principle for himself or allow that principle to lie undisturbed.

A moment's reflection will readily expose the fact that each of the foregoing principles dominates a distinct form of physical activity, or, more correctly, natural force or tendency. It cannot fall far foul of lay observation also that these natural tendencies are so related in gate application as to act in conjunction with, or opposition to, both themselves and each other. Thus, common level plus pressure transmission drives metal rapidly through gates and into their castings. Pressure suddenly applied to a filled mold strains the casting. That is an effect of gravity. A riser gate turns gravity against gravity, absorbs the shock and saves the casting. In all matters of detail the whole philosophy of good gating consists in taking advantage of the situation, of establishing co-operation or opposition between one natural tendency and another. Opposition, being by far the most prevalent, it follows that mainly we must war on gating evils by inciting their producing causes to rebel against each

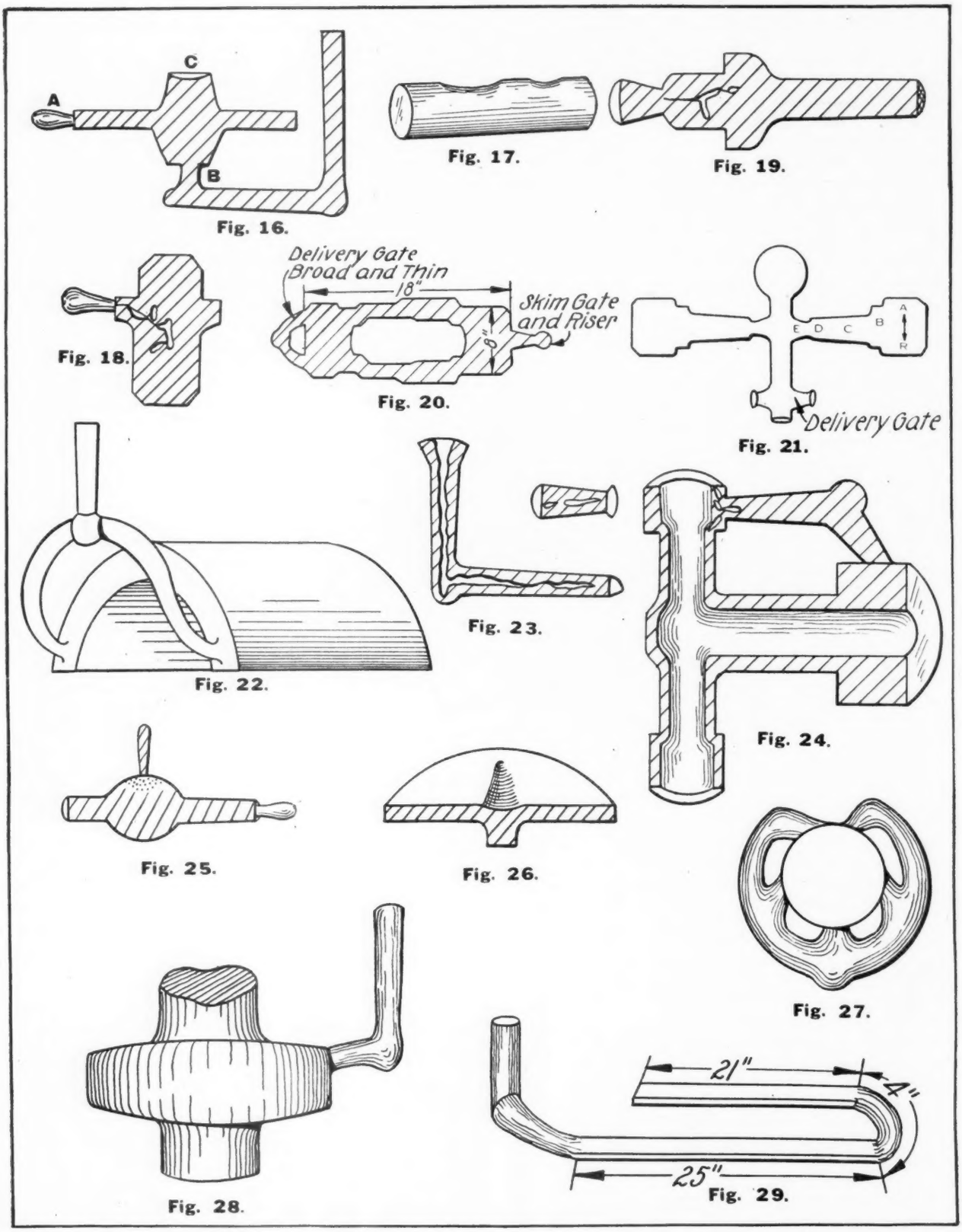


Fig. 16.

Fig. 17.

Fig. 19.

Fig. 18.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

Fig. 27.

Fig. 28.

21"
4"
25"

Fig. 29.

FIG. 16—*A* GIVES SHRINKAGE AT *C*, *B* PREVENTS IT. FIG. 17—A 3 x 12-INCH PIN, GATED AND POURED IN HORIZONTAL POSITION—END GATING AND POURING IS BELIEVED TO BE THE BEST METHOD. FIG. 18—CHUNKY CASTINGS, LARGE AND SMALL, REQUIRE GATES OF VOLUME. FIG. 19—VARIATION IN BULK HAS MUCH TO DO WITH LOCALIZED CONTRACTION—OPPOSITE ENDS OF SPINDLE IS PROPER GATE-ATTACHING VICINITY. FIG. 20—METHOD OF GATING THIN WORK. FIG. 21—CORRECT FORM OF RUNNER AND DELIVERY GATE. FIG. 22—CORRECT PRACTICE IN DOUBLE GATING. FIG. 23—GATES PERMITTING SHRINKAGE CAVITIES TO RUN THE ENTIRE GATE LENGTH OR WHICH TERMINATE CLOSE TO THE CASTING ARE ALWAYS DANGEROUS. FIG. 24—CONSEQUENCES OF DOUBLE GATING UNDER ILLOGICAL CONDITIONS. FIG. 25—EFFECT OF A DIRECT-ATTACHING RISER ON A COPPER BASE CASTING. FIG. 26—EFFECT OF SLIGHTEST VARIATION IN BULK ON ALUMINUM. FIG. 27—GATE USED IN BOTTOM GATING AND POURING THIN BUSHINGS. FIG. 28—A SHRUNKEN COPE—A MATTER OF MORE PRESSURE. FIG. 29—POURED HORIZONTALLY AND WITH A SINGLE GATE, METAL RAN THROUGH A 1 x 1½-INCH STRIP, STRAIGHT AHEAD, AROUND AND UP A TURN INCLINED AT 30 DEGREES AND BACK 21 INCHES—THE ALLOY WAS 85 PER CENT COPPER, 5 PER CENT LEAD, 5 PER CENT TIN AND 5 PER CENT ZINC

other; nullify effects by neutralizing causes; in short, balance the thing up. Every non-ferrous casting run, yet ruined by its gates, represents an illogical order of precedence in these involved tendencies, the unwarranted ascendency one is given over another.

The primary evils of illogical gating are surface-evidenced shrinkage in cope and heavy metal vicinities; hidden weaknesses in casting vitals; pin holes at the gate and casting union leading to spacious inner cavities; drawing between light and heavy sections; exaggerated porosity; cold-shotted or mis-run castings; metal-dross pollution; partial or complete dislocation and breaking of cores; solid burning of cores and green sand mold vicinities; swelling of the casting; metal filling of core vents superinducing core blowing; localized vicinities of mold and metal dross in the casting; casting partition; occlusion of gases, etc. So manifold in detail are the causative sources of these consequences that we pass them by in the interests of those considerations in which their remedies lie. These considerations cover four distinct phases of gating practice, as follows: General features, gate selection, gate form and volume, and gate placement.

General molding skill and practice has much to do with the efficiency of a gate. The most trivial error of judgment often will start something of serious consequence. Best molding practice is always requisite to assured results. Gate-surrounding sand should be of sterling quality and in the very best condition. If too dry or weak in body, it will wash away; if too wet or strong, cutting with the same casting—impairment follows. Tamped too soft, its swelling deprives the casting of intended and requisite pressure; too hard, cutting and scabbing again appear. Liquids transmit stock as well as pressure, a knocking or boiling in the funnel of the pouring-gate is transmitted to the mold, superinducing unrest in menace to the casting. A leak between successive sections of an added pressure gate always involves a diminution of mold pressure. A purpose of the button gate is to absorb shock of impact from falling metal; to be logical it must be consistently soft, not only in the surface but gradually receding to its hard background of sand deeper down. Great volumes of metal in rapid transit through gates, play hard on naked sand surfaces. A coating of dry plumbago, well-rubbed in, is a great protection. Pouring and drop gates of great depths permit a metal momentum at their termini beyond green sand button-gate capacity to resist, and the dry-sand-core button gate, therefore, must be resorted to. Connecting, runner and delivery gates, slanting upwards from source to terminus, break the force of flowing metal and in bottom gating and skim gate positioning are tributary to cleanliness of mold metal. The force of an inrushing current and its impact against the green sand core and pocket complement of a mold can be broken by a consistent turn in the horizontal direction of the delivery gate. Great complacency in current can be realized by backing the metal to a point away from the casting, thence into the casting. When conflicting conditions eliminate these precautionary measures, the situation often can be controled by intercepting the force of the rushing current with a small dry sand core positioned at the point of impact in the mold. We have found this a most successful medium of relief to green sand cores of shallow bushings, rings, etc. These are but a few of the great mass of considerations involving common sense and headwork in gating and illustrate the difference, for instance, between the molder lightly facing a cope with good sand and then filling in with any old sand, and the one seeing to it that every square inch of gate surface is amply backed with the very best sand.

Gate selection has to do with the type of gate used for different classes of work. In all cases the pattern should be carefully studied and the gate made to fit the occasion. Many a defective brass casting is the direct result of some inconsistency on the part of the molder who should have reasoned out his problem before he laid the pattern on the follow-board. This business of first doing a thing and thinking about it afterwards is very bad practice in gating. The type of work has everything to do with the type of gate. The three most common types of delivery gates are the horizontal surface, the horn and the U-gate, the former applying to the common, ordinary classes of work to whose logical gating vicinity it is easily accessible, such as horizontally-cast bushings, valve bodies, stems, pin brass, etc. The horn and the U (virtually modified forms of each other) apply to gating vicinities beyond the reach of the horizontal surface gate. Examples of their application are thin discs with heavy centers, tooth-cast gear wheels, heavy bottom, light top classes of work, and bottom-gating in the absence of flask parting along the gating plane. The flow-off applies to prolonged liquidity and circulation of metal in a mold as exemplified in silencing a blowing core or casting copper-base metal on iron, the feed gate attaches to high and heavy vicinities. Bottom-gating proves its advantage in the deeper molds whether heavy or medium and even in the lighter class of work such as bushings cast on end. The riser gate is necessary to molds of extensive cope area and all cases where extremely hard pouring is essential to results. The skim gate answers to the call for advanced metal cleanliness and the drop pouring gate takes up the task at the limit of skim gate capacity. The drop-pouring gate also will run a thin casting practically impossible to most of the other ordinary methods. An example of its running capacity and the absolute purity of its casting product is shown in Fig. 14, which illustrates the running of a thin disc, 1/16-inch thick and 3 x 4½ inches, without the semblance of a flaw, along with a valve body weighing about four pounds. In no part of the heaviest section and the highest point of the body was there the slightest trace of metal impurity. The alloy used was half new, half scrap and very close to the following specifications: Copper, 86 per cent; tin, 6 per cent; lead, 2 per cent, and zinc, 6 per cent. The pres-

Tests on Metal Shrinkage

Cement or alloy.	Maximum depression, in. in.	Position of depression.	Surface affected sq. in.	Depres'n regular or irregular
Copper and small per cent of silicon	1/8	Central	10	Regular
Aluminum	1/8	Central	7	Regular
Zinc	1/32	Central	8	Regular
Tin	1/16	Beyond center opposite gate	3	Regular
Lead	1/8	Center	3	Regular
Cu. 90, Al. 10	5/64	Center	6	Regular
Cu. 85, Pb. 5, Sn. 5, Zn. 5	1/8	Center to outer edge opp. gate	5¼	Regular
Cu. 66⅔, Zn. 33⅓	1/8	Center	9	Very irregular
Cu. 80, Sn. 10, Pb. 10	1/8	Opposite gate beyond center line perpendicular to gate	3¾	Regular
Cu. 88, Sn. 10, Zn. 2	1/4	Center	4½	Irregular

sure and added pressure gates are extremely necessary to a driving force and a holding power. They force non-ferrous metals into molds and hold them against mold-gas pressures and the recessions of contraction. Many a thin casting has tarried on its way to ruin pleading this driving force. Since it opposes shrinkage, the gate varies in height with bulk of metal, the metal's expanding and contracting tendency, its form in the mold and its degree of fluidity in pouring.

Form and Volume

Form and volume are most critical considerations. By one the action of metal is controled in the gates and its ratio of bulk to radiating surface determined; by the other, the evil of contraction in the casting is dominated. Surfaces of all gates should be uniformly smooth in order that maximum complacency in flowing metal be realized. The average alloy has a high specific gravity taking sternly to task the resistance of sand, and whatever in gate surface will prevent metal commotion is well worth considering. Metal in commotion disassociates and cools rapidly, thus subjecting the casting to an additional adverse influence. For heavy and medium-bulk work, ingress gates should represent maximum volume bounded by minimum surface. In all plane figures bounded by straight lines, polygons, those of equal dimensions, equilaterals, enclose greatest area within the same perimeters. Thus, a square 3 x 3 inches, contains one square inch more surface than a rectangle 2 x 4 inches, though the distance around both is the same. Since volume represents surface multiplied by the third dimension, it is quite evident that the equilateral type of any form of gate, whether triangular, rectangular or whatever, is the logical maximum-volume, minimum-surface selection.

The circumference of a circle is less than the perimeter of any polygon of equal area. Rationally, then, the bounding surface of the cylindrical gate is less than that of any other form of equal volume. Being true of the whole, it is true of the parts, and gives the semi-cylindrical form of gate the advantage over the triangular or any other form equal in volume and to the same purpose. To such forms we personally adhere most closely, and while molders may find it impractical to follow principles of construction to the letter, they can at least approximate them to advantage. In gating plate work for machine molding service, the plan can be faithfully followed to maximum of result in casting status and gate metal saved.

In the lighter and greater-surface classes of work, gate volume recedes in importance and form must alter to meet new conditions. No light or thin casting should be accorded runner and delivery gates much more bulky than the casting itself. These shallow transmitters, under proper pressure, keep compact bodies of metal in rapid transit. It is the opinion of the author that mis-running of thin castings is more a consequence of partition and loitering than either low temperature or inherent tendency in metal.

Gate form often menaces the welfare of the mold. To reduce the evil,

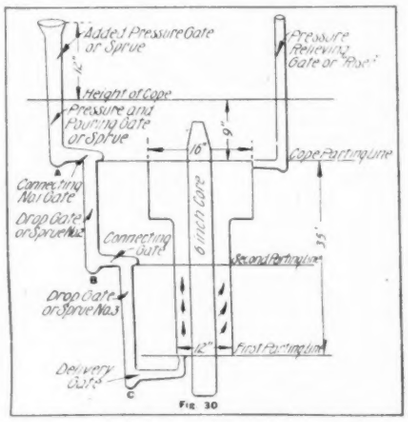


FIG. 30—ILLUSTRATING THE USE OF PRESSURE, CONNECTING AND DROP GATES

horn gates should admit radii of curvature assuring a safe body of sand between their self-created openings and those portions of the mold they underlie. The same applies to U-gate dimensions. Button gates should represent cones diminishing downward and terminating in a circular basin. They should be cut on radii greater than the drop gate and positioned directly under it. At the immediate point of mold attachment, all gates should enlarge to fillet effect. Metal in ingress gates is hotter than that in the mold; that in egress is colder. It follows that in the same mold their forms must necessarily differ. Cooling in advance of mold metal and bereft of any substantial pressure, the egress gate must represent a minimum of contracting tendency to which reduced volume and increased surface logically apply. The skim gate derives its efficiency from its mechanism and position. In those of independent lead, the principle is to intercept a stream of metal en route to the mold, trap its dross into a by-path and permit the metal, thus clarified, to enter the casting. In mechanism, the gate varies with variation in idea of different practices. Very frequently the dry sand core is resorted to, admitting mechanism not practical to the green sand. Egress skim gates are usually parts of risers and pass off mold-accumulating dross. Positioned at highest points of mold or in vicinities to which ingress influence directs the mold current, and broad-cut to encompass sufficient mold surface, they promise best results.

The primary evil of contraction attending liquid to solid reduction is a draw or shrinkage cavity, bound to locate in either gate or casting. To keep it out of the casting is a chief end in gating. Tributary thereto is slight and gradual reduction from source to mouth in gate volume, and ample pressure. Every gate entering a mold should observe these principles of construction. It requires very little force of logic to convince, that if a delivery gate at point of union with the casting is dimensioned to its volumetric requirements, at that point and every linear unit back of that point slightly larger than at that point, there can be no natural chance of a congealing metal mass in the casting, drawing on an empty source of supply. The fact is that with maximum volume bounded by minimum space, its diminution from source to mouth and a driving pressure behind it, we have three powerful influences conspiring to defeat the ends of contraction in the casting and against which that contraction cannot prevail unless aided by some external influence.

Gate Area at Point of Attachment

Gate area at point of attachment to the casting is highly critical. If excessive, every gate behind it wastes metal; if too small, it is incapacitated to its function, and shrinkage in the casting results. Propriety must seek its promptings in conditions at hand and as affecting individual cases. Volume in the casting in relation to surface, fluidity of metal at correct pouring temperature, distance from gate entrance to extreme point of metal transmission in the mold, pattern variation in bulk, nature of metal used, and all must be taken into serious consideration. Bulky castings, large or small, require greater gate volume regardless of apparent insignificance; a 4-inch square disc, 2 inches thick, will get along better with the same gate volume than a 3-inch cube though the former represents 5 cubic inches more in solid contents. Gates as large or larger than the casting represent folly. The drop gate in Fig.

15 was made by an ordinary lead pencil and ran a 2-pound bulky casting perfectly clean and solid. By this the contention is not set up that lead pencils make appropriate drop gates, but rather that the lead pencil is as logical as the saw log. The pin-brass, etc. A gate attaching to a heavy bulk, reducing backwards to a lighter, often produces pin holes and cavities in the heavier bulk. The heavy bulk being closer the gate out-liquidates both lighter section and gate, being drawn on by the former streams of metal approaching each other from opposite directions are, to say the least, well within the province of suspicion.

Wherever admissible, the bottom method of gating is the ideal. Its advantages are manifold and plain.

Practical Gating Pointers Culled From Shop Experience

The smallest gate or set of gates conducive to casting quality, are the logical ones in non-ferrous work.

Smaller gates will answer for copper—tin—lead than those alloys including zinc along with them.

A gate's capacity to perform its function varies with the degree of fluidity of the metal in pouring.

Ingress gates are more critical in constructing than egress gates and in the main, are opposite in principle to them.

The volume of all gates tributary to it should be reckoned from the volume of the delivery gate at its point of union with the casting.

A good fillet will operate against a draw and will prevent the in-breaking of gates removed from hot castings.

Sharp angles at turning points of gates are not conducive to best results.

A good, gate-cutting molder can cut a better and cheaper gate in the sand for mounted plate work than a patternmaker can make a pattern for. The gate thus cut can be poured, finished and attached to the plate.

A form pressed into the sand to make a button gate is a *bone-head* play in molding.

Connecting gates cut above flask parting surfaces give better service than those cut below.

The top of a riser gate always should be covered in mold pouring.

Pressure is derived from height, independent of volume.

Pressure at any point in the mold equals height of gate above that point divided by 28 and multiplied by the specific gravity of metal involved.

Higher pressure is necessary for scrap than new material.

Touching-up a head gate aids feeding, but yields no additional intensity of pressure.

A leak in the gate reduces pressure in the mold.

Metal sinking rapidly in a pressure gate may indicate a swelling casting.

If the shrinkage cavity in a pouring gate descends to the gate's lowest point, its extension upward or increase in its volume is requisite.

Ratio of gate pressure to casting volume varies. A pressure gate, 21 inches high, produced a perfectly solid and unshrunken, solid disc weighing 1,000 pounds, poured with 2/3 new, 1/3 old 80-10-and-10 metal.

Correct pouring of a mold has a distinct bearing on the accomplishment of its gates.

Gate pin holes in the casting result from a variety of causes. Among them are hard ramming, wet sand, lack of pressure, improper construction or placement, double gating and cold metal.

All gates should observe a minimum in safe distance to or from the mold.

Green sand gate transmission of large volumes of metal finds additional safety in properly skin-dried gates.

Double gates of unequal volume, or those attaching to light and heavy casting sections respectively, superinduce shrinkage.

Pouring should be started in a feed gate the moment metal from the mold enters the same, otherwise the gate may freeze or its colder metal may be driven back into the casting, porosity resulting. The same applies to the double pouring of molds.

A green sand head or pressure gate yields best results in pouring chill-made, copper-base castings.

In the drop-pouring method, pressure applies most suddenly and should be intercepted by strength of mold with riser gate relief.

Molds containing delicately anchored cores should be so gated and poured that rising metal plays on the minimum of core surface. If, for instance, a vacuum cleaner, gate and pour it on its end.

A stream of metal playing throughout pouring on a given core surface, is liable to burn the core solid at the contact point.

A gate situated too close to the edge of the flask is a menace to the casting.

Killing two birds with one stone is a great stunt in gating. If a riser can be made to perform its own and skim-gate functions, take advantage of the situation.

The use of water in gates is bad practice.

Gating from one casting to another admits a chance of both being bad.

A single gate cut at such an angle as will direct the metal current to a circular motion in the mold answers best for ring-shaped castings.

Double gating superinduces drawing, sends two streams meeting at a point opposite the button gate, depositing all their dross at that point and often failing to unite properly.

Cope shrinkage usually is a consequence of cold metal and poverty of pressure. *Drawing* can follow the same, though it is just as likely to result from variation in bulk of metal. Both are consequential also to errors in molding practice.

Every pressure gate should slightly and uniformly overtax its mold-resisting power. I don't like an absolutely finless casting.

Heavy work delivery gates require that volume only that will satisfy the demands in the critical zone of the casting, which critical zone is the vicinity of gate attachment. It is folly to so *volume* all gates as to out-liquidate, in entity, their castings.

Elevating the pouring ends of molds of horizontal gating to aid in running the castings is a delusion. Metal runs to best casting advantage when driven either up-hill or on the level by ample pressure behind it. It runs down-hill better, but it doesn't always hang together in so doing.

Excessive hand tamping will stop a thin gate from running.

High temperature metal is most exacting on gates. Cold metal creates greater friction but forms its own protection by its surface congealation.

Logical order in relative position to the button gate has much to do with efficiency of gates attaching to loose pattern work. Hotter metal, and greater pressure in consequence, locates nearest the source of the gate.

Capacity to run a casting yields to direction forced on the metal by the gates. Very often a thin casting worked along with heavier work will do better at the extreme end of the runner gate than from a gate branching from the button gate, a matter of direct and rapid transit.

At their union therewith, the bottom surfaces of all delivery gates should approximate, though never exceed, the surface of the runner gate.

By sawing a trial gate in half and examining its inner condition, much valuable information, not otherwise evidenced, can be obtained on the true worth of the gate.

Delivery gates with pinholes leading up to the casting are weak, while a central cavity running longitudinally the entire length of the runner gate is evidence of illogical conditions somewhere regardless of casting appearance.

In all cases of the highly duplicated type in loose pattern work, by making sufficient patterns to fill a flask and a master gate for continuous service, great saving and efficiency can be realized.

Scientific gating makes dead-sure of everything happening in gate connection. Before putting them in service, all set gates should be thoroughly tried out and investigated, and the logic of theory thus checked against the infallible logic of results in practice.

instance in immediate question demonstrates the efficiency of logical gate construction, the power of the pressure gate and the advantage of a correct pouring temperature.

Gate placement is another critical consideration. As in gate volume, everything depends on conditions. Generally, castings do better gated on the end than at middle points, the consideration finding application in bushings, stems, plugs, valve bodies and derives no ultimate supply from the latter. Gating onto heavy sections connected with lighter ones pre-supposes a larger gate than the opposite. When bulk difference is not excessive, the better plan is to attach to the lighter section. In multiple gates attaching to light castings, position and current should be so determined as to lead streams to unite in the mold enroute through it. Unions of recoiling metal, or in In both the heavy and the lighter classes of work, it will be found conducive to results. Possibilities in the latter are greater than lay judgment might suspect. For purely experimental purpose the author once got a perfect casting from a ⅛ x 1½-inch strip, 30 inches long, by pouring it in a vertical position and gating it at the bottom. In thin, cylindrical classes of work, one form of practice is to cast upright largely and to pour

from the lowest position in the mold. The chime-whistle body is an example. In its pouring, metal winds in and around mold-congesting cores to a height of 14 inches running with fidelity very thin walls and webs, and a central bushing. Primarily, the advantages of bottom gating are as follows: (a) it makes the drop gate a skim gate; (b) it prevents disassociation of metal; (c) it graduates core gas formation and gives it free escape upwards; (d) it keeps vapor pressure ahead of the metal, and lessens its confinement in pouring; (e) it positions the delivery gate at the point of maximum pressure forcing a compact metal union; (f) it limits force and commotion of falling metal to a locality of licensed freedom in construction; (g) it sweeps everything ahead of it insuring surface position of mold-developing dross; (h) it generates greatest background vapor pressure in that vicinity of the mold where greatest metal pressure is present to resist it; (i) it practically eliminates shrinkage at the point of gate attachment.

In the main, it appears that in casting, copper and aluminum are chiefly disturbed by these two opposite tendencies; that in combination they get little relief from it; that with the addition of lead and tin intensity recedes while in the presence of zinc it again jumps into prominence. A further observation is that whatever the immunity of new material to shrinking tendency that immunity becomes conspicuously absent with repeated remelting. To formulate a definite comparison of shrinking tendency between different elements and alloys in casting, a series of tests were roughly made. Dry sand molds were resorted to and a solid disc pattern, 4 inches in diameter and 1⅝ inches deep, was used. Semi-circular delivery and round pouring gates were selected, the pouring gate having been ¾-inch high and the delivery containing 7/20 cubic inch per linear inch. Half new and half scrap metal was melted in a small crucible, under best of practice, and the molds poured, with the results in shrinkage as indicated in the table entitled "Tests on Metal Shrinkage", which appears on page 515.

These results can be relied upon only in a comparative sense, for after all, the main evil of contraction in casting derives more from variation of bulk than from bulk itself. In the test, aluminum shrinkage did not show up so strong. As stated, dry sand molds yielded an advantage and in casting it must be considered that aluminum is, by virtue of its low specific gravity, a green-sand-abhoring metal. For this reason sand accommodating aluminum gates should be worked as dry and bodily impoverished as conditions will permit. The flow-off and the pop gate work out to advantage in aluminum. The better form of pop gate is that of a common wedge, diminishing downward and attaching to the casting with a very thin edge.

How a Large Machine Was Repaired by Welding

WHAT is claimed to be the largest weld ever made, is described by H. D. Kelley in a recent issue of *Reactions,* published by the Goldschmidt Thermit Co., 120 Broadway, New York. The weld consisted of the thermit repair of large cast iron shears for the 48-inch blooming mill at the plant of the Pittsburgh Steel Co., Monessen, Pa. Mr. Kelley, who is a representative of the Goldschmidt Thermit Co., describes the making of this weld, as follows:

"A piece of steel became wedged between the stationary blade and movable blades of the shear, breaking off entirely the stop holding the stationary blade. The broken piece was of irregular shape, approximately 37 inches wide by 5 feet 6 inches long and weighed about 3,000 pounds.

"I was called upon to inspect the shears March 1, 1916, and ordered material by telegraph that day to be shipped from our Jersey City plant by express. In the meantime the shears were patched temporarily so as to enable them to run the mill until the arrival of the material. The mold box was made and sand secured and as soon as the welding material arrived on the ground and everything was ready for the weld I returned to Monessen to direct the work of repairing the large machine.

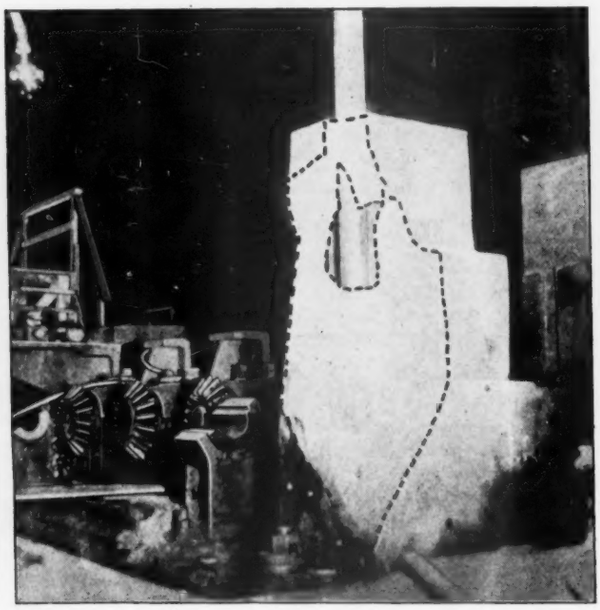


FIG. 1—THE DOTTED LINES INDICATE THE EXTENT OF THE PIECE THAT WAS BROKEN OFF THE BLOOMING MILL SHEARS

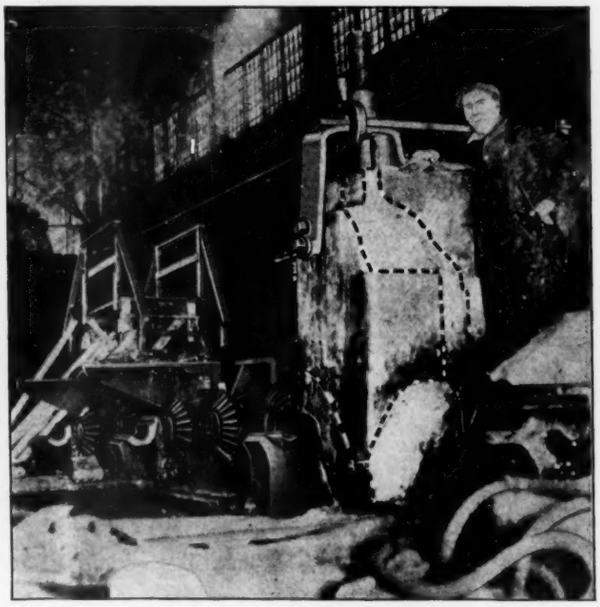


FIG. 2—A BROKEN PIECE PLACED IN POSITION WITH THE WAX PATTERN APPLIED JUST BEFORE BUILDING-UP THE MOLD

At 12:30 p. m. Saturday, March 11, the mill was shut down and the work of stripping the shears commenced. The fractured parts were thoroughly cleaned and the broken piece placed in position ready for welding. This part of the work was completed by Sunday morning, at which time the work of applying the wax was started and the mold box placed in position. This was a square sheet iron box 110 inches x 119 inches deep with no bottom or top. The box was hoisted into position by means of a traveling crane and oxy-acetylene was then used to cut the bottom of the box so as to fit properly over the shear frame. When the box was firmly anchored in position the big job of ramming the molding material commenced. This, however, was completed Monday afternoon.

"Five No. 10 crucibles were then supported over the mold box and filled with cast iron thermit, everything being ready at about 9 o'clock Monday night when the preheating was started. Three burners from preheaters were used and kept going until 5 o'clock Tuesday afternoon, when the casting was hot enough to permit of pouring the weld. The preheating holes were then plugged, the thermit ignited and the resulting metal poured into the mold. This was completed just 84 hours from the time the work was started.

"The weld was poured successfully and was allowed to stand until noon of the next day, Wednesday, when the front of the mold box was taken off, thus exposing the front of the weld only. The object of this was to allow the heat to radiate from the main body of the casting through the weld. The rest of the mold was left on until 6 o'clock that evening when it was taken off. The metal left in the risers was cut off and as there was no other machine work to do the reassembling of the shear was started and finished by 7 o'clock the next morning, March 16. One hour later, 8 a. m., the mill was started and has been doing business every minute of the time since.

"It will be seen, therefore, that the mill was only shut down from March 11, at 12:30 p. m., to March 16, at 8 a. m., which I think is a record for such a large repair."

In the accompanying illustrations, Fig. 1 shows the large extent of the fracture, the dotted lines indicating the break after the broken part was removed. Fig. 2 is a view of the blooming mill shear after the part broken out had been placed in position and properly braced. The dotted lines show the wax pattern shaped for the thermit weld. Fig. 3 illustrates the finished thermit weld on the shear casting. The straight, vertical line indicates the corner of the casting, while the dotted line shows the extent of the weld and how the casting was reinforced. Fig. 4 is a view of the mill showing the completed repair. The dotted line indicates the extent of the weld.

Henry E. Pridmore, Chicago, manufacturer of molding machines, is building an extensive addition to his plant.

The Werner G. Smith Co., Cleveland, manufacturer of core oil binders, has established a Chicago office in charge of Albert L. Fay, formerly affiliated with the Holland Core Oil Co., of that city. The Werner G. Smith Co. will carry a warehouse stock in Chicago and all shipments in the western territory will be made from that point.

Eliminating Cracks in Sand-Cast Rolls

Roll foundries frequently experience considerable difficulty from microscopic cracks appearing in the surface of large sand-cast sheet mill rolls. Frequently, where pit capacity is limited, these rolls are cast on one side with several gates entering tangentially at the circumference. These gates are spaced at equal distances along the length of the roll. The cracks occur particularly with low manganese mixtures which are frequently necessary nowadays on account of the high price of ferro-manganese. The cracks usually develop after giving the rolls a thermal treatment.

A microscopic examination undertaken by a foundry in southern Ohio has indicated the cause of the trouble. It appears that when two streams of metal entering through adjacent gates collide, a thin film of manganese-sulphide forms at the junction. This inclusion is the basis of the cracks which make their appearance later.

The only way yet discovered to avoid the trouble is to change the method of molding, casting the rolls on end and pouring the metal through a single gooseneck gate. If this method is adopted there is no opportunity for manganese sulphide films to form through the junction of adjacent streams of molten metal.

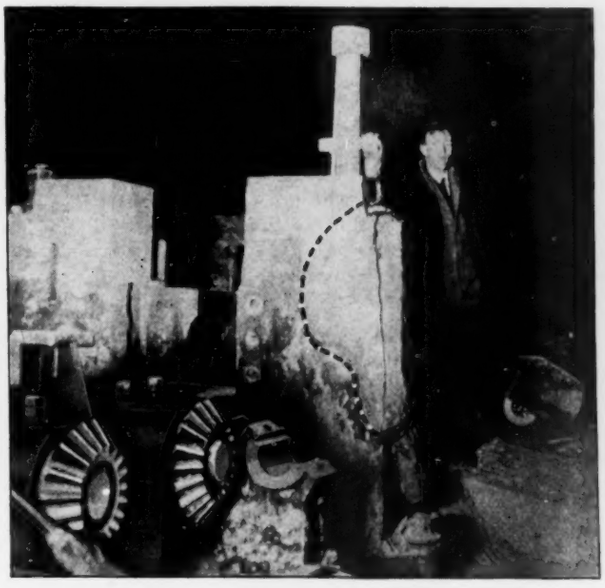


FIG. 3—THE DOTTED LINES SHOW THE EXTENT OF THE THERMIT WELD AND HOW THE BREAK WAS REINFORCED

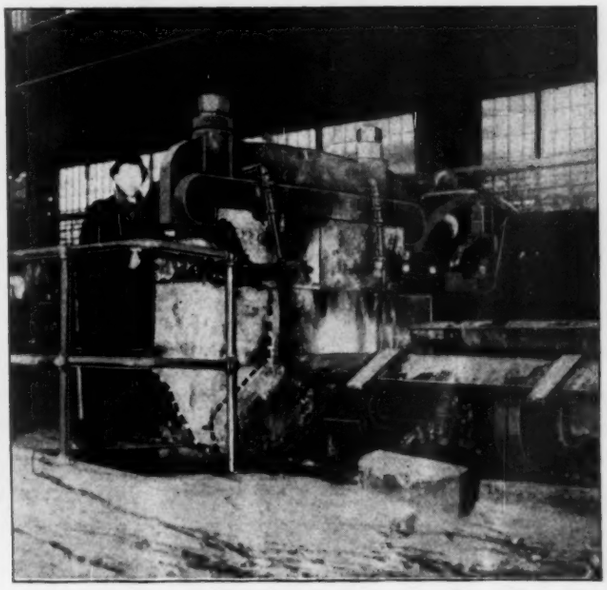


FIG. 4—THE BLOOMING MILL SHEAR ASSEMBLED AND RUNNING. THE DOTTED LINES SHOW THE THERMIT WELD

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.	Prince's Chambers
CHICAGO	1521 Lytton Bldg.
CINCINNATI	404 Johnston Bldg.
NEW YORK	508 West Street Bldg.
PITTSBURGH	2148-49 Oliver Bldg.
WASHINGTON, D. C.	206 Corcoran Bldg.

SUBSCRIPTION

United States and Mexico	$1.00 a year
Canada	$1.50 a year
Great Britain and other Foreign Countries	Eight Shillings
Single Copies	15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

ENTERED AT THE POST OFFICE AT CLEVELAND AS SECOND CLASS MATTER

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Is Traditional Indifference Passing?

EACH succeeding industrial crisis reveals a new weakness in American business men. The gauntlet of labor unrest, car shortage and sky-high prices, through which we are now struggling, strikingly reflects the indifference that men of affairs have manifested in the framing of our national policies toward business. The men who complain most bitterly of the injustice of some of our laws are in too many instances the ones who have been satisfied to allow politicians to introduce the objectionable legislation. Now, in the midst of prosperity, these men find that regulations are throttling the effectiveness of their efforts. They are rudely made to realize that if they are to have legislation favorable to their interests, they must share the responsibility of enacting it.

That foundrymen are alive to the errors of the past, is evidenced by the resolution recently passed by the National Founders' Association endorsing the action of the railroads in carrying their fight against the Adamson law into the courts. Regardless of the merits of the principle involved in this particular case, the interest in a national issue, implied by this act, is commendable. It is to be hoped that it is the forerunner of a general tendency on the part of foundrymen to make their wants known to the administration and to the public. If the present industrial disturbances ultimately succeed in focusing the attention of business men upon Washington, a task of untold benefit to the country will have been accomplished.

Trade Outlook

CONFRONTED on one side by a tremendous demand for castings, and on the other by the scarcity of labor, poor transportation service and high prices of fuel and iron, foundrymen are hard pressed to make prompt deliveries. Many new casting plants, recently completed or in the course of construction, are making it more difficult for furnace operators and coke makers to meet the requirements of their customers, and this has been responsible for increasing difficulties all along the line. The car situation has gradually taken first rank in the list of influences that are throttling production, finally superseding the labor problem as the principal factor in business. The excess of the demand over the supply has boosted prices to unusual levels, and prompt deliveries are obtained only by the payment of exorbitant premiums. Pig iron prices during November advanced at the rate of from one to three dollars a week, and foundry coke has sold at as high as $11. Contract foundry coke has left $5, quoted late in October, far behind, and is now hovering between $6 and $6.75, Connellsville. Bessemer pig iron is quoted at $30.95, Pittsburgh, and basic is held at from $27 to $30, Pittsburgh. No. 2 foundry iron quotations in the various markets follow: Pittsburgh, $26.95; Chicago, $27 to $28; Birmingham, $20 to $23; Ironton, $25 to $26; Philadelphia, $25.50 to $26.50; Cleveland, $26 to $27; and Buffalo, $26 to $27. Lake Superior charcoal iron is quoted at $26.75 to $28.75, Chicago. Malleable is held at $26 to $28, valley; $27 to $28, Chicago, and $26 to $27, Buffalo. Spot Connellsville foundry coke is sold at from $9.50 to $10. Prompt coke prices vary within wide limits depending largely upon the car supply, which is governed by weather conditions in the Connellsville region. With winter at hand, there is little, if any, chance for the railroads to improve their car service.

Foundry Methods to be Investigated

At the annual meeting of the National Founders' Association, held at the Hotel Astor, New York, Wednesday and Thursday, Nov. 15 and 16, announcement was made of the establishment of a committee on foundry methods which will investigate and prepare bulletins on the selection and installation of molding machines, foundry cost systems and operating methods applying to the manufacture of castings. The establishment of a service bureau was recommended. The commitee consists of Joseph J. Wilson, Cadillac Motor Car Co., Detroit, chairman; H. P. Parrock, secretary; W. M. Gartshore, John Knickerbacker, D. W. Sowers and P. J. Flaherty. One bulletin already has been issued, which is devoted to the discussion of the benefits to be derived from the use of molding machines.

Campbell Foundry to be Enlarged

In the November number of THE FOUNDRY, page 480, reference was made to the new gray iron shop which is being erected by the Campbell Mfg. & Foundry Co., Muskegon, Mich. It was stated that the main building will be 19 x 180 feet, whereas this structure is to be 110 x 180 feet, with two 30-foot side bays and a center bay 50 feet wide, which will be commanded by a crane. The estimated cost of the building and the foundation is $40,000. A specialty will be made of light gray iron, machine-molded castings, including small castings for the automobile trade.

Personal

R. W. Howell, formerly affiliated with the Springfield Machine Tool Co., Springfield, O., has accepted a position as foundry superintendent of the Miller Improved Gas Engine Co., of the same place.

John H. Davis formerly superintendent of the plant of the Chester Steel Castings Co., Chester, Pa., has accepted a similar position with the Acme Steel Co., Akron, O.

W. F. Davidson, formerly associated with the Reliance Steel Casting Co., Pittsburgh, has been appointed works engineer of the Granite City, Ill., works of the American Steel Foundries.

R. S. Ramsey, formerly connected with the Pressed Steel Car Co., has been appointed manager of the Bellwood Mfg. Co., Bellwood, Pa., which operates a foundry and machine shop.

G. A. White, formerly metallurgist of the American Sheet & Tin Plate Co., Pittsburgh, now is associated with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., in the same capacity. Prior to his affiliation with the American Sheet & Tin Plate Co., Mr. White was affiliated with the Rock Island railroad and with the Eastern Steel Co., Pottsville, Pa.

Death of W. C. Cuntz

William Cooper Cuntz, general manager and a director of the Goldschmidt Thermit Co., New York City, died Thursday, Nov. 2, at Auburndale, Mass. Mr. Cuntz was on a visit for the benefit of his health, which was impaired by an operation for appendicitis a year ago. Born at Hoboken, N. J., in 1871, Mr. Cuntz was educated at the Hoboken academy and at the Stevens Institute of Technology, graduating in 1892 with the degree of mechanical engineer. His first practical experience was with the Pennsylvania Steel Co., Steelton, Pa., in the bridge and construction department, which he represented as resident engineer at Boston and as European resident engineer in London, Eng. Later he entered the sales department, serving as assistant general manager of sales and later as district sales manager at Steelton, Pa. At the outbreak of the Spanish-American war he volunteered for service in the artillery. In 1910 he was appointed by President Taft a delegate to the International Railway Congress at Bern, Switzerland. During the same year he severed his connection with the Pennsylvania Steel Co. to become director and general manager of the Goldschmidt Thermit Co. Under his management the business of this company not only has increased materially, but equal progress has been made in the technical development of the thermit process. His wide experience in the steel industry caused him to take particular interest in the manufacture of carbon-free metals and largely to his perseverance and initiative these metals and alloys are coming into general use. Mr. Cuntz is survived by his widow and two sons. He was a member of the American Iron and Steel Institute, American Society of Civil Engineers and a large number of other technical organizations and clubs.

John Alderdice & Co., Warrnambool, Victoria, Australia, would like to receive price lists and catalogs from manufacturers of gray iron and brass foundry equipment and supplies. If possible, quotations should be made f. o. b., New York.

New Abrasive Plant

Harrison Brothers, Amesbury, Mass., have completed a new plant devoted to the manufacture of artificial abrasives. The output includes chilled shot and diamond grit or crushed shot, which is used extensively for sand blast purposes, and for sawing and polishing granite, marble and sandstone. Harrison Brother's plant at Middlesbrough, England, which was established in 1887, has been disposed of as a going concern. The new building is five stories, 70 x 160 feet, of brick and steel construction, and has capacity for producing about 15,000 tons of abrasives a year. The output of the company has been sold for the past 20 years by the Harrison Supply Co., 5 Dorchester avenue, Boston; the sale of the sand blast abrasives is in the hands of the New Haven Sand Blast Co., New Haven, Conn.

Death of Andrew Rodgers

Andrew Rodgers, a foundryman of wide experience and a molding machine salesman of great ability, died at Norwood, Pa., on Nov. 1. At the time of his death he was affiliated with the Herman Pneumatic Machine Co., Zelienople, Pa., in the capacity of molding machine salesman, having been connected with this firm for a period of seven years. Prior to this time Mr. Rodgers occupied positions of varying executive capacities with the foundry department of the Baldwin Locomotive Works, Philadelphia, having been employed by this company for a period of 25 years. Mr. Rodgers was 56 years of age.

Will Move Offices

The Multi-Metal Separating Screen Co. announces that on December 1 it will move its offices from 68-72 East 131st street, New York, to 247-253 West Nineteenth street. The change has been made necessary by the rapid growth of the company which has made the present quarters inadequate. A large floor area will be available in the new plant, affording room for the installation of additional special machinery and labor-saving devices. For the benefit of visitors a show room in which a full line of helmets and respirators will be exhibited is being fitted up.

The United States Magnesite Corp., 11 Pine street, New York City, has been organized to mine, mill and ship all grades of magnesite, including crude, calcine, dead-burned, etc. This company also is now offering to the trade all grades of foreign and domestic magnesite.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Atlantic Steel Castings Co., Chester, Pa., will erect additions to its plant.

The Carthage Foundry & Machine Co., Carthage, Mo., is building a $15,000 plant.

The P. F. Mork Foundry Co., Beloit, Wis., is erecting an addition, 50 x 150 feet.

A one-story foundry will be erected by the Coin Machine Co., Portland, Ore.

A contract has been let for the erection of a 60 x 85-foot foundry by Morris Broomfield, 146 Franklin avenue, Chelsea, Mass.

Plans have been completed for a 34 x 110-foot machine shop to be erected for the Buffalo Foundry & Machine Co., Buffalo.

The French Creek Foundry Co., Franklin, Pa., will build a 2-story addition, 60 x 70 feet.

The Dayton Malleable Iron Co., Dayton, O., contemplates erecting an addition to its plant at Ironton, O.

The Mueller Furnace Co., Milwaukee, will erect a one-story foundry, 110 x 182 feet, and a two-story building, 27 x 50 feet.

The Standard Machine Co., Owosso, Mich., is building a foundry, 50 x 80 feet and a two-story machine shop, 40 x 120 feet.

Henry Wray & Sons, Inc., Rochester, N. Y., will erect a 50 x 62-foot foundry and machine shop addition at a cost of $20,000.

The General Electric Co., West Lynn, Mass., will erect a steel foundry, 100 x 190 feet, and a factory building, 60 x 310 feet.

Charles H. Birmingham and H. Taylor, Munsey building, Baltimore, Md., will build a 70 x 244-foot foundry.

Joseph Sticka, Algoma, Wis., will enlarge his foundry and machine shop and will install new equipment.

The Novo Engine Co., Lansing, Mich., will build a 100 x 120-foot addition to its foundry at a cost of $50,000.

A $12,000 brick addition, 80 x 85 feet, will be built by the Maynard Steel Foundry Co., Milwaukee, Wis.

A brass foundry to cost $30,000 will be erected by the Niles Tool Works Co., Hamilton, O.

A contract for a one-story foundry addition, 72 x 96 feet, has been let by the G. S. Youngs Co., Bridgeport, Conn.

The Northern Malleable Iron Co., St. Paul, Minn., will build a foundry at a cost of $7,000.

The Gary Foundry & Machine Co., Gary, Ind., contemplates doubling the capacity of its plant.

The O. K. Foundry Co., Richmond, Va., will build an addition to its plant at a cost of approximately $5,000.

A 75 x 160-foot foundry for the manufacture of desk castings will be erected by the Southern Desk Co., Hickory, N. C.

The Waterbury Castings Co., Waterbury, Conn., has awarded the contract for a one-story addition.

The Chicago Bell Foundry Co., Chicago, has been incorporated with $2,500 capital, by F. L. Stetson, C. W. Taylor and John Roeder.

The Elmira Foundry Co., Elmira, N. Y., has been incorporated with $95,000 capital, by H. C. Mandeville, A. P. Morrow and F. Le Valley.

A one-story addition, 30 x 56 feet, will be erected to the foundry of the Rider-Bagg Co., Springfield, Mass.

The American Ball Valve & Mfg. Co., Detroit, has been incorporated to engage in the operation of a foundry and machine shop. The company is capitalized at $50,000 by Arno and Herman A. Miller and Carl E. Reichle.

A contract for the erection of a 44 x 45-foot brass foundry has been awarded by the Oxweld Acetylene Co., 646 Frelinghuysen avenue, Newark, N. J.

The Perfect Machinery Co., Galt, Ont., Can., is building a brick and concrete foundry addition, which will be L-shape, 60 x 24 feet and 20 x 26 feet.

The South Bend Brass Foundry & Machine Co., South Bend, Ind., will build a plant at Mishawaka, Ind. R. G. Fayer is president.

The Dover Foundry Co., Canal Dover, O., will be incorporated shortly to engage in the manufacture of ingot molds. A plant will be erected for this purpose.

A contract has been placed for an 80 x 120-foot foundry to be erected for the New Brunswick Iron Works, New Brunswick, N. J. The estimated cost is $14,000.

A new company, headed by Paul Maiwurm, will establish an aluminum foundry in Ashland, O. The erection of a foundry, 40 x 160 feet, is contemplated.

The James Clark Jr. Co., Louisville, Ky., manufacturer of motors, tools, etc., contemplates adding a foundry department to its plant.

The Stern Foundry & Machine Co., New Orleans, La., will expend $100,000 in improvements to its plant, which will include a foundry and machine shop.

The Belleville Commercial Foundry, Belleville, Ill., has been incorporated with a capital stock of $2,400 by Felix Rhein, A. F. Weichert and Alfred Ziehnert.

The Colonial Foundry & Machine Co., York, Pa., has been incorporated with a capital stock of $20,000. G. R. Shenberger is treasurer.

J. A. Constantine has purchased and will place in operation the Supplee foundry, Columbia, Pa., recently operated by the Keystone Boiler Works, now at Landisville.

The Kramm Foundry Co., Indianapolis, Ind., has been incorporated with a capital stock of $50,000 by H. D. Kramm, W. S. Wilson and C. B. Mock.

The Fairmount Foundry Co., Woonsocket, R. I., recently incorporated with $35,000 capital, by Matthew M. Sweeney, George E. Bouvier, Clifford Teachman and Charles W. Meyman, will build an addition.

The Shell-Bar Grate Co., Toronto, has been incorporated with $40,000 capital to engage in the operation of a foundry. The provisional directors are Joseph M. Bullen, Harold L. Steele and Wendell Osborne, of Toronto.

The Hoosier Iron Works Co., Kokomo, Ind., recently organized by J. W. Johnson, C. T. Byrne, George Kingston, J. P. Grace and A. G. Seiberling with $200,000 capital, will erect a foundry, pattern shop and office building.

A contract has been placed by the Doehler Die Casting Co., Court and Ninth streets, Brooklyn, N. Y., for the erection of a steel and concrete addition to its die casting plant. The proposed structure will be 50 x 100 feet, seven stories, and will cost approximately $150,000.

New Trade Publications

MAGNETIC SEPARATORS. — A bulletin recently issued by the Magnetic Mfg. Co., Milwaukee, is devoted to the line of magnetic separators which it manufactures for use in brass foundries and metal refineries. The bulletin contains data on the standard sizes of separators built, as well as details of their construction and operation.

TRUCKS AND TURNTABLES. — The Whiting Foundry Equipment Co., Harvey, Ill., has published a 16-page bulletin devoted to trucks and turntables. The trucks are designed especially for heavy shop work. They are fitted with chilled cast-iron wheels, steel axles, and steel frames with steel or wooden tops. Steel roller bearings are used. Many special kinds of trucks including dump cars, core oven cars, special heavy drying oven cars, electric transfer cars, etc., are described. Several types of turntables including plain faced, single and double tracked are illustrated.

HEATERS.—A comprehensive catalog containing 136 pages, issued by the B. F. Sturtevant Co., Hyde Park, Mass., is devoted to the heating system which bears this company's name. The first part of the book describes the operation, construction and mechanical details of Sturtevant heaters and is intended for those who are not buying this class of apparatus regularly. The latter part of the catalog, which gives performance tables, diagrams and dimensions, is for the benefit of engineers, architects and steamfitters and will enable them to choose the heater necessary for any given building. Diagrams showing proper methods of making steam connections and the space occupied by the heaters also are included.

BUILDING DESIGN AND CONSTRUCTION.—A series of seven folders descriptive of recently constructed factory buildings has been issued by Frank D. Chase, industrial architect and engineer, Peoples Gas building, Chicago. Interior and exterior views of the new plants of the Moline Malleable Iron Co., St. Charles, Ill.; Wilder Tanning Co., Waukegan, Ill.; Garden City Spring Co., Chicago; Temple Mfg. Co., Cicero, Ill.; Hammond Malleable Iron Co., Hammond, Ind.; and the American 3-Way Prism Co., Laporte, Ind., are shown and testimonial letters from officers of these companies are reproduced. One of the folders contains a tabulated record of the construction of the Moline Malleable Iron Co. plant, showing that the new buildings were completed and ready for occupancy three months after fire destroyed the old plant. Accompanying the descriptive matter in the other folders are statements regarding economies, especially in the buying of building materials, effected by the Chase company.

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